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113—Journal Section of the American Society of Heating and Ventilating Engineers

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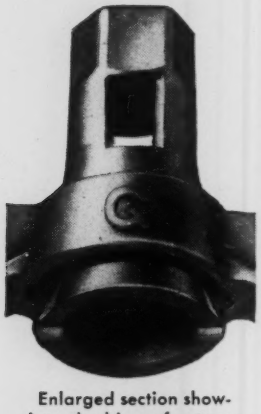

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WHENEVER **PIPING** IS INVOLVED

THE EDITOR'S PAGES

SIX-MONTH CONSTRUCTION TOTALS $7.7 BILLION

Paced by a gain of 60 percent in expenditures for new housing, the total volume of new construction in the first half of 1948 reached $7.7 billion, an increase of more than $2 billion over the same period of last year, the Construction Industry Information Committee stated last month.

Expenditures for all new building, as estimated by the bureau of labor statistics and the U. S. Department of Commerce, were 35 percent greater than in the first half of 1947 and were the largest for any corresponding period on record.

Gains were made in every type of private construction, except industrial building, which dropped 19 percent. However, the volume of other nonresidential private building, including stores, warehouses, office buildings, garages, and churches, was 50 percent higher than in the first six months of last year.

COMMUTE IN AIR CONDITIONED COMFORT

Four air conditioned commuter club passenger coaches have been placed in service by the Jersey Central Lines, according to E. T. Moore, chief executive officer of the railroad. They are being leased from the Jersey Central by commuter clubs.

In a questionnaire several months ago, commuters were asked whether or not they would be interested in participating in a travel plan to secure the advantages of air conditioned commuting at cost. About 1000 commuters answered in the affirmative, and the formation of several commuter clubs followed.

Under the plan worked out by the railroad, the clubs will pay on a 15 year amortization basis the initial cost of the air conditioning equipment and its installation. The fixed charges for this will amount to about $1.53 per person a month if it is divided among 65 club members and proportionately less as the number of members is increased. The overall expense for the air conditioning will depend largely on the wishes of the club members, but it is estimated the total cost per person for 65 members will be about $3.30 a month during the hot weather months, with the equipment operating five days a week on the evening homeward trip, which is what most of the clubs seem to want. On this basis, with the air conditioning equipment operating four of the summer months, the average total monthly cost per person for the year with 65 members in a club will be about $2.65 in addition to regular commutation fares.

BUILDING TRADES APPRENTICES INCREASE

The number of apprentices at work in the building trades has increased at a faster rate than the physical volume of new building during the last 12 months, according to David S. Miller, president of the Producers' Council.

"However, it will be necessary for employers to continue to attract more young men into the building trades because the new selective service act undoubtedly will take a considerable number of these apprentices during the next year and because a portion of the skilled building trade workers normally retire from active work each year," he said.

ACRMA OPPOSES CONTRACTOR LICENSING

"Registration or licensing of air conditioning and refrigeration contractors is contrary to the best interests of the public and of the air conditioning and refrigeration industry", said the board of directors of the Air Conditioning and Refrigerating Machinery Association in its recent meeting at Hot Springs, Va. In unanimously adopting a statement of policy on the subject, these industry leaders drew particular attention to the possibility of abuses inherent in contractor licensing and its effect on users of the industry's products.

Following is the text of the statement as adopted:

"ACRMA believes that registration or licensing of air conditioning and refrigeration contractors is contrary to the best interests of the public and of the air conditioning and refrigeration industry.

"Licensing requirements provide a ready and convenient channel for abuses such as the limiting of competition by excessive fees, through unreasonable requirements, and through administration by examining boards and enforcement agencies which may be less than impartial. Excessive fees, unreasonable examination requirements, and similar features tend to limit free and competitive enterprise and create barriers to interstate and intercommunity commerce.

"Licensing charges must be reflected in higher overall costs of air conditioning and refrigeration installations to the buyer, without any assurances of quality of equipment, proper installation, and safe operation of air conditioning and refrigeration installations."

ASTM APPROVES NEW SPECS AND TESTS

With more than 135 technical papers and reports of the society's committees, some 360 committee meetings, and an extensive exhibit of testing and research apparatus and laboratory equipment, the 51st annual meeting of the American Society for Testing Materials at Detroit again emphasized the importance of work in materials.

As a result of recommendations by the society's committees which are responsible for initiating and carrying through work on specifications and tests for materials, there were 52 new tentative specifications and tests approved and about 70 existing tentatives are to be adopted as standard subject to society letter ballot during the summer.

Richard L. Templin, assistant director of research and chief engineer of tests, Aluminum Co. of America, was elected ASTM president for 1948-1949. L. J. Markwardt, assistant director, U. S. Forest Products Laboratory, Madison, Wis., is the new vice president to serve with the senior vice president, J. G. Morrow, metallurgical engineer, Steel Company of Canada, Ltd.

THE EDITOR'S PAGES

STUDYING SCHOOL AIR CONDITIONING

A study of year 'round air conditioning in southern schools has been initiated in New Orleans as a cooperative plan of the Louisiana Education Foundation, the Orleans Parish school board, and Tulane University.

AFA IS NOW THE AFS

The American Foundrymen's Association, 222 W. Adams St., Chicago 6, 52 year old technical organization of the castings industry, has voted to change its name to American Foundrymen's Society, Secretary-Treasurer William W. Maloney has announced.

"In unanimously recommending the name, American Foundrymen's Society," Mr. Maloney said, "our bylaws and executive committees and board of directors pointed out that it is more descriptive of our functions, and that it conforms to the general practice in the names of other large, recognized technical and scientific groups."

DESCRIBES FACILITIES FOR TESTING FANS

The Texas Engineering Experiment Station, A & M College of Texas, College Station, Texas is the official testing agency of the Propeller Fan Manufacturers' Association. The facilities for testing propeller fans, available to all fan manufacturers, is described in leaflet No. 2 published by the college.

250,000 NONRESIDENTIAL BUILDINGS IN LAST YEAR

The building industry has constructed more than 250,000 new nonresidential buildings, in addition to starting nearly 900,000 dwelling units of all kinds during the last year, according to an analysis prepared by economists of the Construction Industry Information Committee, according to Melvin H. Baker, its chairman.

"Included in the total are 3000 churches, 2800 schools and libraries, 43,000 stores and warehouses, 13,600 factories and workshops, and more than 3200 office buildings," Mr. Baker said.

"When measured numerically, there has been a tremendous improvement in the profile of our cities since the war ended. More than 500,000 new nonresidential buildings of all kinds have been put under construction since V-J day, in addition to the more than 2,000,000 housing units which have been started."

$16.4 BILLION FOR CONSTRUCTION THIS YEAR

The value of new construction this year is expected to total about $16.4 billion, according to a revised forecast prepared by the construction economics committee of the Producers' Council, David S. Miller, council president, said in a recent report to the organization's board of directors.

"It is estimated that expenditures for new building in the second half of the year will be about 10 percent higher than in the first six months of 1947, and that the total for the entire year will be about 17 percent greater than last year", Mr. Miller said.

"Although industrial building is expected to decline 22 percent in volume, a gain of 44 percent is anticipated in commercial construction.

"A rise of 18 percent is forecast in expenditures for new farm building, and a gain of 22 percent seems likely in public utility construction.

"Private residential construction is expected to approximate $6.2 billion. This would mean an increase of 18 percent over 1947 and would account for slightly more than 50 percent of all new private construction.

"The volume of publicly financed construction is forecast at $3.9 billion—24 percent of all new activity, and 27 percent above the 1947 total. Expenditures for highway construction are estimated at $1.5 billion, a rise of 20 percent over the total for last year.

"The council's economists believe that the supply of both labor and materials generally will be adequate to meet the demand reflected in the forecast. However, they point out that continued spot shortages of some materials, particularly items requiring steel, are likely. Assuming no further major work stoppages or wholesale diversions of materials to war production, the list of materials likely to continue in tight supply during 1948 is narrowed down to iron and steel items and millwork."

BUILDING CONTRACTS SET NEW RECORD

The F. W. Dodge Corp. has reported that May construction contracts in the 37 states east of the Rocky Mountains established the highest peacetime dollar volume ever recorded in a single month. The total of $970,789,000 was exceeded only once before, and that was June 1942 when war construction was at its peak. The record monthly total in the 37 states set six years ago was $1,190,264,000, and was comprised principally of heavy engineering and industrial building projects.

The near-billion total this year was 44 percent greater than that reported for May of last year, and was 11 percent higher than the total for April of this year.

All major classifications of construction shared in last May's advance over April and over May of last year, with the most pronounced gains being in nonresidential building.

The cumulative total of $3,831,607,000 for the first five months of 1948 is 33 percent higher than that reported for the first five months of last year, the Dodge records show.

ELMER G. BIECHLER DIES

Elmer G. Biechler, first president and general manager of the Frigidaire Div., General Motors Corp., died in Dayton on July 5. Thirty of his 58 years were spent with Frigidaire and with the parent company, Delco Light.

His rise to leadership is another illustration of the opportunities that America affords. At 12 he was polishing brass and cleaning valves in an ice plant in his native town, Miamisburg, a few miles south of Dayton, for a wage of $1.50 per week.

Heating Piping & Air Conditioning

with which is merged the Aerologist

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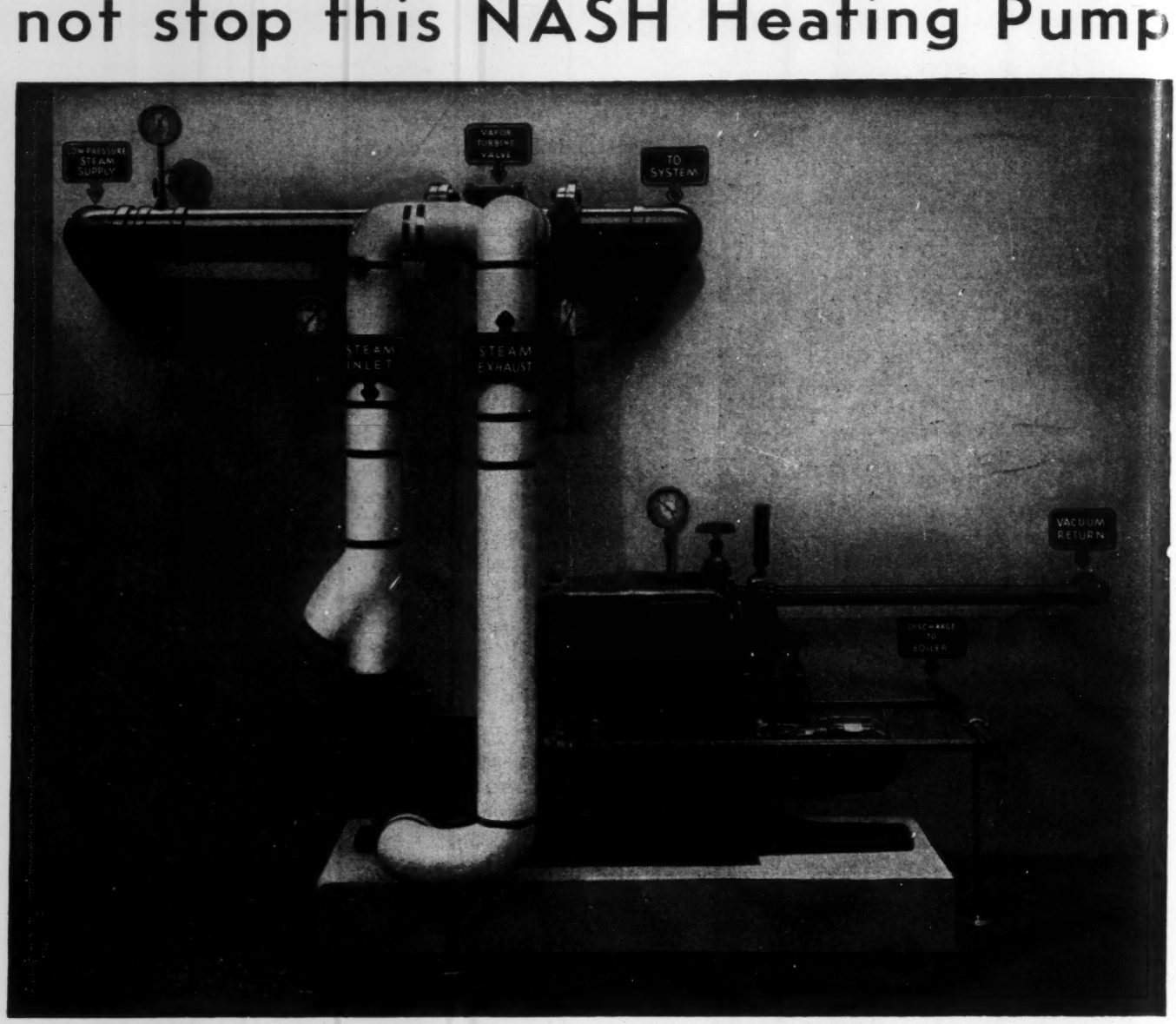
Interrupted Electric Service will not stop this NASH Heating Pump



In Hospitals, Greenhouses, Schools, Public Buildings, Theatres, wherever heating systems must not fail, install the Nash Vapor Turbine, for it is independent of electric current failure, and continues to operate as long as there is steam in the system.

This is because the prime motive power of this economical pump is a special steam turbine, controlled by a unique "Vapor Turbine Valve", which automatically bypasses from the heating main a small portion of steam, the exact amount necessary to develop the power needed to remove the condensate and maintain the required vacuum on the system. Even this small amount is passed immediately back to the mains, and goes on to the system with little heat loss. This pump operates on any system, high or low pressure.

The Vapor Turbine is a most economical pump, for the elimination of electric current does away with current cost, the largest single item in the operation of an ordinary return line heating pump. Bulletin on request.

THE NASH ENGINEERING COMPANY

205-A WILSON ROAD, SOUTH NORWALK, CONNECTICUT, U. S. A.

How to Estimate STANDBY FUEL Required by Interruptible Gas Users

A. B. STICKNEY, engineer, Armour & Co., Chicago, *explains a new approach to analyzing weather conditions in order to determine the amount of standby fuel that will be needed when natural gas is bought on an interruptible basis. The method is generally applicable and has been proved in actual use*

MOST INDUSTRIAL users of natural gas as boiler fuel buy it on an "interruptible" basis. This means that whenever the demand for residence heating, commercial establishments, and other higher priority uses increases beyond a certain point, industrial use is curtailed and the industrial user must either shut down or burn some other fuel. Most industrial users have oil standby facilities and, when their gas supply is curtailed, switch over to oil.

In recent years, the demand for gas has grown faster than the pipe line capacity to supply it. Construction of gas pipe lines was interrupted during the war years, and since the war delivery of materials, particularly large quantities of big pipe, has been very slow. Also, the relative cost of gas as compared to other fuels has made gas much more attractive than it was before the war. Many pipe lines and natural gas distributors have had to limit or refuse new customers until the lines were built up, but even so the demand actually connected has increased much faster than the supply.

The demand of "firm" gas users is largely for space heating, and is tied very closely to temperature—with wind, precipitation, and other factors having a small supplementary effect. Each degree drop in temperature in the area served by a gas pipe line increases the consumption by firm users by a predictable amount, which, on a large system, may be several million cubic feet per day per degree.

Depends Upon Outdoor Temperature

Once the capacity of the pipe line is reached, the interruptible users must be curtailed to the extent necessary to supply the firm users. Generally there are several classes of priority among the interruptible users, tied to rates and size of demand, and these priority classes are curtailed in order. Users in a given priority class are not necessarily all ordered off the line at the same time, but just enough of them are ordered off to balance the demand with the supply. Equitable dispatching requires that users in a certain priority class be curtailed the same amount over a period of time, so that the first user cut off in a given priority class one time is near the last cut off the next time, etc. Suppose curtailments in a given priority class must start at 40 F, and be complete at 30 F. A given user may be cut off at 40 one time, and at 30 another time, but on the average he will be cut off at 35 F, and his requirements for standby oil may be figured on this basis.

The current oil supply situation, and particularly the shortage of tank cars, makes it difficult to obtain delivery of fuel oil on an intermittent basis, particularly for an industrial which uses it as standby for natural gas, and wants it only when the weather gets cold—which is when everyone else wants it also. The only reasonably sure way of obtaining oil is to contract for it for regular delivery throughout the winter, so that refinery capacity is assigned to that contract, and tank cars are assigned to regular shuttle service between the refinery and the user's plant.

But economy requires that only as much oil be purchased as is required during gas curtailments. To do this, the oil requirements must be predicted reasonably close, and tank capacity provided to store shipments received during mild weather for withdrawal to supplement the shipments received during severe weather. Weather is not predictable a long way in advance on a day-to-day or even a week-to-week basis, but the amount of cold weather which can be expected through the course of a winter is predictable within determinable limits. It is the purpose of this article to point out how this can be done, and provide a basis for determining both how much oil is required and what tank capacity is needed to act as a "flywheel" to take up the swings between "normal" weather and actual weather.

Determining Amount of Curtailment

To determine the amount of curtailment to be expected, a new approach to analysis of the weather records is required. The records tell us what the "normal" temperature is at any given time and place, and this is closely related to the degree-day information which has been accumulated.

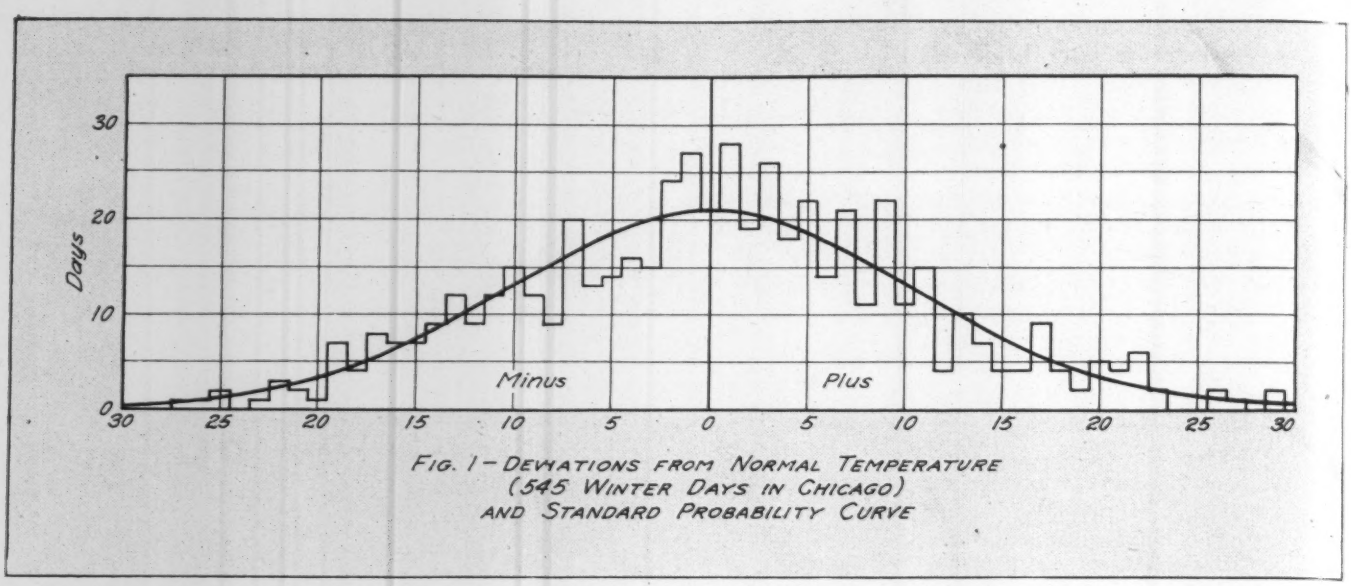


FIG. 1 – DEVIATIONS FROM NORMAL TEMPERATURE (545 WINTER DAYS IN CHICAGO) AND STANDARD PROBABILITY CURVE

But the records also tell us that the temperature fluctuates within wide margins about this normal temperature, so that a protracted spell of normal temperatures is highly abnormal. Normal temperature is simply the average of all the abnormal temperatures actually encountered on the date in question, smoothed with experience on adjacent dates. Normal temperatures, or degree-days, are a good basis for predicting the requirements of a regular fuel through an entire heating season, but are only a starting point for predicting the requirements for a standby fuel.

For instance, normal temperature at a given season may be 25 F, with curtailment expected at 30 F. A month having thirty 25 F days would involve 30 days curtailment, while a month consisting of a warm spell of 15 days averaging 35 F, and a cold spell of 15 days averaging 15 F, would have the same average temperature, but would involve only 15 days curtailment. For this case, we need to know how many days would normally be 5 deg or more above normal, and for a general study we need to know the probability of deviations of all magnitudes from the normal.

To determine tank capacities, we need this information not only on a daily basis but on a monthly and seasonal basis. With such information, we can predict the probability of curtailment on a given day, and the sum of these probabilities over a period will approach the actual curtailments more and more closely as the period gets longer and longer. We can predict the probability of a month and of a season deviating from the normal by a given amount, and evaluate the probability that the swings can be handled by a tank of a given capacity, or conversely the tank capacity needed to handle swings of a certain probability.

A study of daily weather records

Table 1—Percent probability that temperature will not exceed normal temperature plus deviation shown

Deviation, F	Winter days	Summer days	Winter months	Three consecutive winter months	Yearly average
+30	99.80	99.98			
+28	99.65	99.96			
+26	99.29	99.91			
+24	98.95	99.80			
+22	98.28	99.59			
+20	97.28	99.19	99.98		
+18	95.83	98.48	99.93		
+16	93.85	97.28	99.77		
+14	91.09	95.38	99.33		
+12	87.57	92.54	98.31		
+10	83.19	88.53	96.15	99.71	
+ 9	80.66	86.03	94.42	99.35	
+ 8	77.91	83.19	92.13	98.63	
+ 7	74.96	80.00	89.20	97.32	
+ 6	71.80	76.46	85.56	95.10	
+ 5	68.47	72.61	81.16	91.60	99.95
+ 4	64.98	68.47	76.02	86.50	99.59
+ 3	61.35	64.08	70.21	79.60	97.65
+ 2	57.63	59.50	63.82	70.94	90.72
+ 1	53.83	54.78	57.02	60.86	74.60
0	50.00	50.00	50.00	50.00	50.00
— 1	46.17	45.22	42.98	39.14	25.40
— 2	42.37	40.50	36.18	29.06	9.28
— 3	38.65	35.92	29.79	20.40	2.35
— 4	35.02	31.53	23.98	13.50	0.41
— 5	31.53	27.39	18.84	8.40	0.05
— 6	28.20	23.54	14.44	4.90	
— 7	25.04	20.00	10.80	2.68	
— 8	22.09	16.81	7.87	1.37	
— 9	19.34	13.97	5.58	0.65	
—10	16.81	11.47	3.85	0.29	
—12	12.43	7.46	1.69		
—14	8.91	4.62	0.67		
—16	6.15	2.72	0.23		
—18	4.17	1.52	0.07		
—20	2.72	0.81	0.02		
—22	1.72	0.41			
—24	1.05	0.20			
—26	0.71	0.09			
—28	0.35	0.04			
—30	0.20	0.02			

in Chicago for three years was made to determine the probability of deviations of various magnitudes from the normal. Fig. 1 shows this for winter month days (November through April). The number of days which deviated by a given amount, out of a total of 545 days, is shown. Superimposed on this is the standard probability curve,

$$N = \frac{Ch}{\sqrt{\pi}} e^{-h^2\Delta^2}$$

where N is the number of days having deviation Δ, h is a constant (in this case 0.068) which determines the relation of spread to height of the curve, C is the number of observations (in this case 545), and e is the base of natural logarithms.

Similar analysis of 551 summer days gives $h = 0.085$. Taking monthly averages for 73 years in Chicago, the 219 winter months, December, January, and February, give $h = 0.134$; the 73 three-month winter seasons comprising these three months together give $h = 0.195$; and the 73 yearly averages give $h = 0.468$. The constants given for winter days, months, seasons, and years are such that the magnitude of deviation which has the same probability of occurring for various periods is

$$\Delta_{period} = \Delta_{day}\left[1 - \frac{\log_{10}(\text{no. of days})}{3}\right]$$

A more elaborate study might change this formula slightly, but not enough to invalidate the conclusions drawn later in this article.

The percent probability of the temperature deviating from the normal by the amount Δ is

$$\%\ probability = \frac{100}{\sqrt{\pi}} \int_0^{h\Delta} e^{-h^2\Delta^2} d(\Delta)$$

Tables of the value of this integral, expressed in the form

$$y = \frac{2}{\sqrt{\pi}} \int_0^x e^{-x^2} dx$$

are available in standard mathematical handbooks.

Table 1 shows the probability of the temperature not exceeding normal $+\Delta$ for the various periods studied, for various values of Δ. With this table, and with knowledge of the normal temperature, curtailment temperature, and oil required per day during curtailment, we can proceed to evaluate the oil requirements and the tank requirements.

Table 2 shows the computation of standby oil requirements in a normal winter for a plant using oil, when curtailed, at a rate of 500 bbl per day on weekdays, and half this amount on Sundays and holidays, when the normal temperature is as given and the curtailment temperature is 35 F. The last two columns give actual experience last winter, week by week, and cumulative excess or deficiency of actual as compared with computed burn. These experience columns start at December 1, because this particular gas line, which had not previously controlled curtailments of this magnitude, made cutoffs in October and November which were arbitrary and not closely related to temperature. With the experience gained last winter, this arbitrary handling is not expected to recur.

The oil contract for this plant would be based on the sixth column of Table 2, "Probable Oil Required," rounded to even tank car loads.

Table 2—Computation of standby oil requirements, assuming oil usage of 500 bbl per weekday or 250 bbl on Sundays and holidays when gas is curtailed. Oil quantities are in barrels

Week ending	Normal temp.	Δ at which curtailment occurs	% Probability of temp. below 35 F	Weekly burn with 100% curtailment	Probable oil requ'd.	Actual burn last year	Cumulative excess (+) or def. (—), actual over computed
10-2-48	65	—30	0.20	3250	6		
9	62	—27	0.53	3250	16		
16	59	—24	1.05	3250	34		
23	56	—21	2.22	3250	72		
30	53	—18	4.17	3250	135		
11-6-48	50	—15	7.53	3250	245		
13	47	—12	12.43	3000	373		
20	44	— 9	19.34	3250	629		
27	41	— 6	28.20	3000	846		
12-4-48	38	— 3	38.65	3250	1252	1267	+ 15
11	35	0	50.00	3250	1625	2854	+1244
18	33	+ 2	57.63	3250	1873	2415	+1786
25	32	+ 3	61.35	3000	1841	553	+ 498
1-1-49	31	+ 4	64.98	3000	1949	1781	+ 330
8	30	+ 5	68.47	3250	2225	1066	— 829
15	29	+ 6	71.80	3250	2334	2838	— 325
22	29	+ 6	71.80	3250	2334	2994	+ 335
29	29	+ 6	71.80	3250	2334	3005	+1006
2-5-49	30	+ 5	68.47	3250	2225	2202	+ 983
12	31	+ 4	64.98	3250	2112	3120	+1991
19	32	+ 3	61.35	3250	1992	1373	+1372
26	34	+ 1	53.83	3000	1615	1718	+1475
3-5-49	37	— 2	42.37	3250	1377	1505	+1603
12	40	— 5	31.53	3250	1024	2883	+3462
19	42	— 7	25.04	3250	813	367	+3016
26	45	—10	16.81	3250	546		+2470
4-2-49	47	—12	12.43	3250	373		+2097
9	50	—15	7.53	3250	245		+1852
16	53	—18	4.17	3250	135		+1717
23	56	—21	2.22	3250	72		+1645
30	59	—24	1.05	3250	34		+1611
5-7-49	62	—27	0.53	3250	16		+1595
14	65	—30	0.20	3250	6		+1589
				Total =	32708		

Computing Size of Oil Storage Tank

To determine tank capacities, let us assume that the temperature is both 3 deg above and 3 deg below normal, for the three month period of December, January, and February. Table 3 gives the probabilities week by week for normal +3, normal, and normal —3, and also the differences. The average difference between normal and normal +3, applied to the burn for these three months on a total curtailment basis, gives the amount of extra oil in a mild winter which would have to be stored or otherwise disposed of. Similarly, the average difference between normal —3 and normal, applied to the burn for the three months on a total curtailment basis, gives the extra oil required if these three months are 3 deg colder than normal. These figures are

$$0.1098 \times 41{,}500 = 4557 \text{ bbl}$$
$$0.1008 \times 41{,}500 = 4200 \text{ bbl}$$

The sum, 8757 bbl, or 17½ days supply, is the tank capacity required for the plant considered in Table 2 if it is to handle seasons which depart from normal by 3 deg, plus or minus. Such a tank should start the season with 4200 bbl, or a little less than half full. This amount, with regular shipments, would carry the plant for more than a month of continuous curtailment in extreme weather, which the monthly column of Table 1 indicates is extremely improbable.

From the season column of Table 1, we find that a deviation of over 3 deg has a probability of 20.4 percent. This means we would have to obtain more oil one winter in five, dispose of oil one winter in five, and inventory would float within the range of the tank three winters in five. Each year the early shipments would be adjusted to bring the inventory in line.

For any other size of tank, its ratio to that computed for 3 deg can be applied to 3 deg to determine the degrees deviation from a normal winter which it will handle. This number of degrees can be read into the season column of Table 1 to determine the probability that oil must be bought or sold. Thus, a tank of half the capacity would handle a winter season having a 1½ deg deviation, and 34 percent of the winters we would have to buy oil, 34 percent of the winters we would have to dispose of oil, and 32 percent of the winters, or one-third of the time, the tank would be adequate.

On the other hand, a tank of twice the computed capacity would handle a 6 deg seasonal deviation; we would have to buy oil one winter in 20, sell oil one winter in 20, and the tank would be an adequate flywheel nine winters in 10.

Table 3—Percent probabilities week by week for normal +3, normal, and normal —3 temperatures, and the differences

Week ending	Probability of curtailment if temperature is..... Normal +3	Normal	Normal —3	Differences Normal — (Normal +3)	(Normal —3) — Normal
12-4-48	28.20	38.65	50.00	10.45	11.35
11	38.65	50.00	61.35	11.35	11.35
18	46.17	57.63	68.47	11.46	10.84
25	50.00	61.35	71.80	11.35	10.45
1-1-49	53.83	64.98	74.96	11.15	9.98
8	57.63	68.47	77.91	10.84	9.44
15	61.35	71.80	80.66	10.45	8.86
22	61.35	71.80	80.66	10.45	8.86
29	61.35	71.80	80.66	10.45	8.86
2-5-49	57.63	68.47	77.91	10.84	9.44
12	53.83	64.98	74.96	11.15	9.98
19	50.00	61.35	71.80	11.35	10.45
26	42.37	53.83	64.98	11.46	11.15
			Average:	10.98	10.08

Start Season With Tank Half Empty

It is important that the tank be half empty at the start of the season if regular shipments are to be made, since a run of mild weather is as likely as a run of severe weather, and the tank is as likely to have to store oil as to supply it. There is a psychological hazard here, since the inclination is to fill the tank "for protection," whereas the greatest real protection consistent with economy is to have regular shipments coming in, with the tank starting half full and acting as a flywheel.

While the examples given are for a specific plant, the method is generally applicable, and the probabilities in Table 1 may be used for any climate similar to Chicago's. This approach to analyzing weather data is, to the best of the author's knowledge, new, and may have many applications besides that given here.

Construction Industry Plans For Progress

The construction industry appears to be on the threshold of the greatest period of progress in its history, surpassing even the era that brought in the steel frame, reinforced concrete, insulation, and the improvements in heating, lighting, and ventilating that changed the whole aspect of American building, according to a report on recent technological progress issued by the Construction Industry Information Committee. The present movement has been stimulated by the necessity for overcoming war-created materials and labor shortages, on the one hand, and the desire for broad and continuous markets on the other.

All elements of the construction industry are contributing to this advance, says the report:

Both labor and management are attacking the problem of increased productivity through better relationships and improved practices.

The use of mechanized tools and equipment is being expanded.

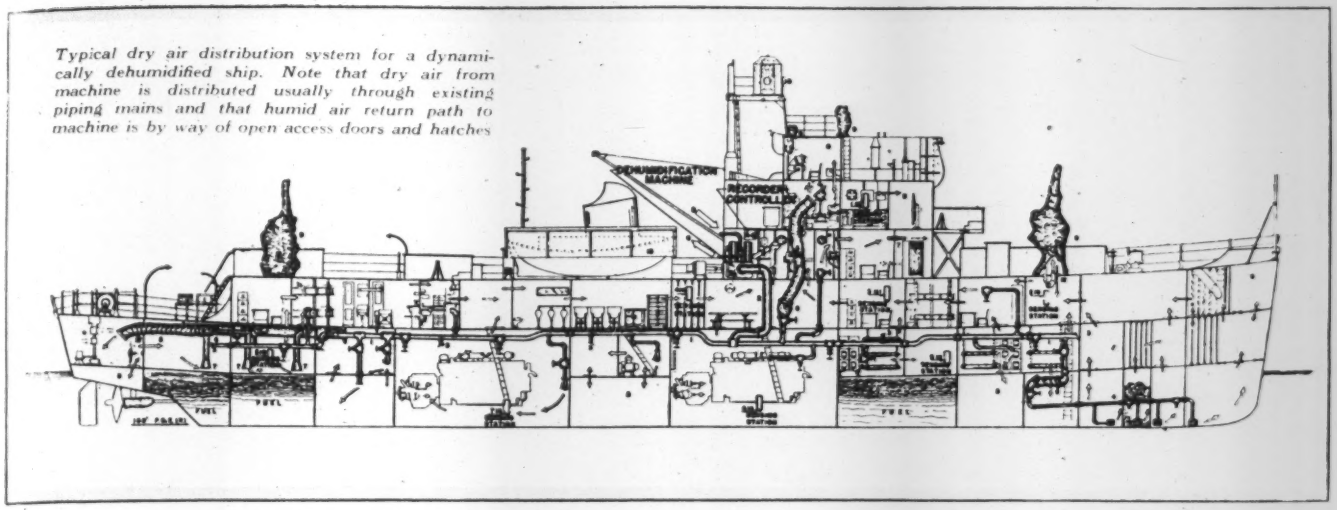
Simplified methods of handling and storing materials are being adopted.

More efficient materials are being provided.

Building regulations are being liberalized to keep pace with industrial progress.

The double task of restoring the functioning of the industry from its end-of-the-war disorganization, and of meeting the extraordinary demands upon it in the face of constantly mounting inflationary pressure, has prevented a full recognition of the result so far attained.

Nevertheless, the improvement has already been striking; and its impact will be steadily more apparent in the ability of industry to reach wider markets with products of better quality than has ever been true in the past, the report states.



Typical dry air distribution system for a dynamically dehumidified ship. Note that dry air from machine is distributed usually through existing piping mains and that humid air return path to machine is by way of open access doors and hatches

Dehumidification Protects Materials from Deterioration

Tests Indicate Value of Controlled Humidity

THE NAVY is placing primary reliance on maintenance of an atmosphere having comparatively low relative humidity for the preservation of interiors of ships which are retained as a part of the Navy but in inactive status. Nearly three years have elapsed since the undertaking of application of dehumidification to reserve fleet ships as a practical means of preventing their deterioration. The time which has elapsed permits that a reasonable evaluation of the adequacy of dehumidification for this purpose be made.

In the period between World Wars I and II, many advances were made in the development of preservative coatings and in the techniques of their application. It was apparent, however, that preservative coatings alone would not insure the protection of the materials for indefinite periods of time. It was further apparent that for a vast number of components which go to make up a ship in a condition of material readiness, such that it could perform its designed functions without elaborate overhaul and costly reassembly at a time of activation, there was no practicable means of applying preservative coatings.

Knowledge of the effect of atmospheric conditions on corrosion of metals, mold, mildew growth, and general deterioration of equipment indicated that control of relative humidity within the ship would result in ideal protection of all equipment located within the envelope. The Navy's bureau of ships, from the end of World War I until 1941, as the opportunity afforded, conducted tests with a view to determination of the practicability of such humidity control. Because of the indefinite need for specific information, however, not much formal effort along these lines was expended in this period. During this time, one company pioneered the idea and successfully accomplished the installation of machines

The opinions expressed herein are those of the author and do not necessarily reflect or represent the views of the Navy Department.

COMMANDER GEORGE C. WELLS, USN, in a paper which was adjudged the best of those submitted in the 1948 prize essay contest of the American Society of Naval Engineers, Inc.—and which is published here by permission—reports on the results of the Navy's program for the long-time preservation of the interiors of ships on inactive status by maintenance of relative humidities of 30 percent. Results of the program (details of which were given in an article by Thomas H. Urdahl and Elmer R. Queer published in the March '46 HPAC) have been excellent, and the method should be of interest to all concerned with protecting various materials against the ravages of time plus moisture

and systems for the preservation of cargo by dehumidification. At the beginning of World War II, development efforts necessarily were diverted to higher priority items of active fleet equipment.

As the war progressed, it became evident to the bureau of ships that upon termination of hostilities there would be huge quantities of materials which would require preservation at the lowest possible cost. Under direct leadership of Captain H. Gordon Donald, Captain Thomas H. Urdahl, and Commander Elmer R. Queer, an intense program of research into the adequacy of dehumidification and into the development of practicable methods for its accomplishment was instituted. Resultant to accelerated tests, conclusions were drawn that:

a) The maintenance of a relative humidity of 30 percent would prevent deterioration from corrosion, mold, and mildew.

b) This relative humidity was practicable of attainment within the envelope of a ship.

c) Items of equipment and outfit could be allowed to remain aboard in their normal location, allowing the ship to serve as its own storehouse.

d) The distribution of dry air to permit attainment of uniform conditions of relative humidity was practicable of accomplishment.

Concurrent with research into the adequacy of principle, the bureau of ships, with the full cooperation and valuable advice of manufacturers, developed machinery suitable for the accomplishment of the job. Before the end of the war, necessary equipment characteristics had been established. With the cessation of hostilities, machines to perform the work were in production.

Solid Desiccant Is Drying Agent

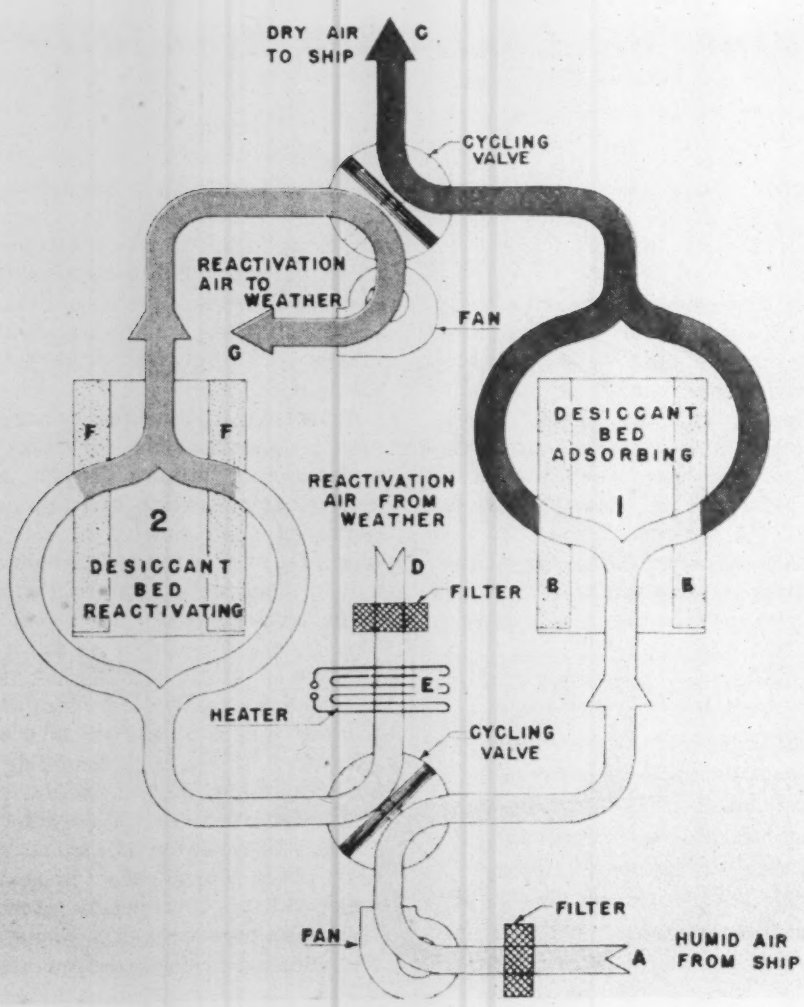
The dehumidifiers built employ solid desiccant as the drying agent. Energy for reactivating the saturated desiccant beds is electrica . A fan having sufficient availab total pressure to circulate dry a through distribution mains is bui integral with each dehumidifie . The machines are completely aut - matic in operation, working on a timed relationship between adsor - tion and reactivation cycle for the desiccant bed concerned. All but the smallest dehumidifiers in service are dual bed machines and can continuously deliver dry air to the ship. The desiccants employed last indefinitely and require no change.

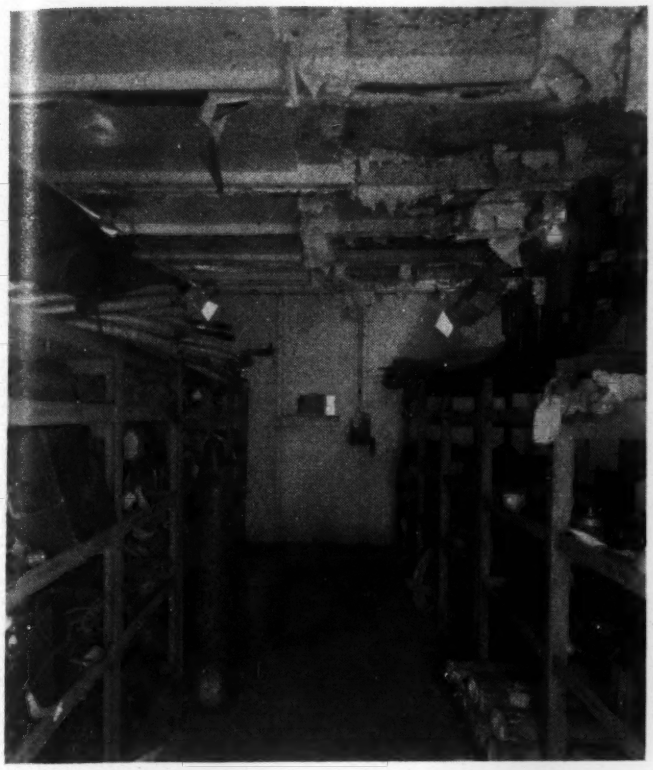
The ship is prepared for dehumidification by being made as tight to wind and weather as practicable. Since the ship's envelope is inherently a watertight structure and forms an excellent vapor barrier, it has been found feasible to make the ship adequately tight with but small expenditure of labor. The ship is divided into as many separate zones as must be employed to permit adequate dehumidification of each zone by one machine. The dehumidifier is installed to recirculate air within the zone. Dry air from the dehumidifier is distributed to all areas of the zone by use of existing piping mains. The return air path to the machine is provided by leaving open selected access doors and hatches. In the selection of air paths, due regard is given to the prevention of progressive flooding of the ship in event of accidental breaching of any compartment.

Equipment external to the ship's envelope, and which is subject to deterioration from the effects of the atmosphere, is housed within inexpensive, weather- and airtight, portable metal structures. The source of dry air to be circulated within these structures may be either the air within the ship's envelope or a low capacity automatic "package" dehumidifier. Selection of means of drying external equipment is made on the basis of the lower installation cost. Spaces within the envelope, through which it is found impracticable to circulate dry air, are kept dry by being opened to spaces where dry air is circulated. Very small quantities of dry air relative to volume of the zone being dried are recirculated.

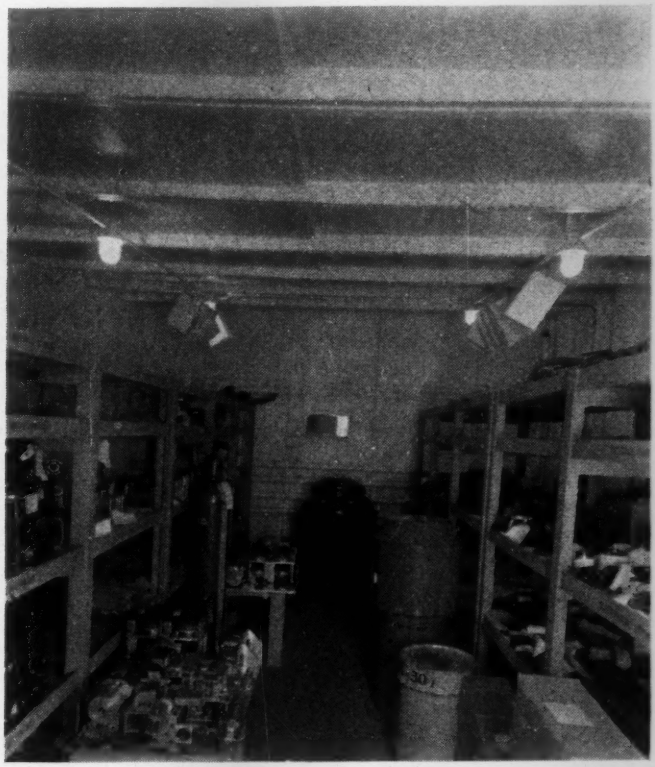
Numerically, the major proportion of ships under preservation are dried by a single machine. All ships

Typical air circuiting for a dual bed dehumidifier





General view of test cabinet after three years exposure to atmosphere of 90 percent relative humidity



General view of test cabinet after three years exposure to atmosphere of 30 percent relative humidity

of destroyer size and smaller have only one machine installed. Ships of cruiser size and larger auxiliary vessels usually require that three machines be installed. The largest combatant vessels require the use of eight machines.

Recorder-Controller Maintains 30 Percent Average

The dehumidifier is started and stopped as required to maintain an average relative humidity of 30 percent within the zone by a recorder-controller. This unique instrument is a joint development of the bureau of ships and an instrument manufacturer. The instrument consists of a central recording and control station to which are connected eight stations for sensing relative humidity and temperature. The eight sensing stations are located at representative points within the zone.

The central station receives, and prints in Arabic figures on an adding machine tape, the temperature and relative humidity existing at each sensing station location, averages the humidity readings, and energizes or stops the dehumidifier based on this average humidity reading. The instrument may be set to control and record continuously or at selected time intervals. It has been established from experience that sampling of air conditions and attendant control of the machines once each 12 hr is sufficient to maintain an acceptably uniform level of relative humidity with the space concerned. The general practice, therefore, is to record and control at this time interval.

The effort required to prepare a ship for dehumidification is, as would be expected, directly a function of her material condition at the time of inactivation. Preservative measures within the ship's envelope, preliminary to the application of dehumidification, consist of cleaning and drying machinery and systems which in their functional nature contain water or are exposed to grease and contaminating oil vapors. Appropriate thin film rust preventative compounds are applied to the interior working surfaces of the machinery. These compounds have characteristics such that they need not be removed prior to use of the equipment. The thorough elimination of all free water inside the ship's envelope forms an important part of these steps. To be prepared for successful application of dehumidification, all underwater leaks must be stopped. Leaks which permit the seepage of free water above the waterline as a result of rainfall present far more troublesome sources of moisture than do openings to the weather which permit the entry of moisture laden air only. Ships of all-welded topside construction present fewer problems than do those of riveted construction.

Experience has clearly shown that a condition of pressure tightness is not essential to the satisfactory operating economy of dehumidification equipment. It has equally demonstrated the fact that the equipment is operationally a costly bilge pump and that considerable care to prevent entry of free water is requisite to the successful application of dehumidification.

Is the Scheme Practicable?

Many questions as to the efficacy of dehumidification may be raised. Some questions which may occur and the answers as they now appear to be evident may well be presented:

Is it indeed practicable to maintain and control effectively humidity aboard ship? Acceptable conditions are being successfully maintained on ships located in widely

separated geographical areas. The ships require time varying from two weeks to two months in their initial drying period—that period of time during which residual moisture is being removed from materials within the envelope. After an equilibrium condition of 30 percent is attained, it is successfully being maintained within a range of plus to minus 5 percent from the average, using the methods of control earlier discussed. The scope of this successful application can be appreciated when it is realized that over 3000 machines are now in service.

Is humidity control costly of maintenance? The average maximum power requirements to date are 5000 kwhr per month per million cubic feet of dehumidified volume, the approximate volume of four ships of destroyer size. The average minimum requirements on vessels ideally suited for dehumidification are considerably less than half this requirement. In dollars and cents, assuming a power cost of $0.012 per kwhr, a ship of destroyer size is maintained in a satisfactory condition of relative humidity at a power cost of approximately $180 a year. This is indeed a small price to pay for the preservation of so valuable an item of defense equipment as a ship of this type and size.

Humidity Control Is Essential

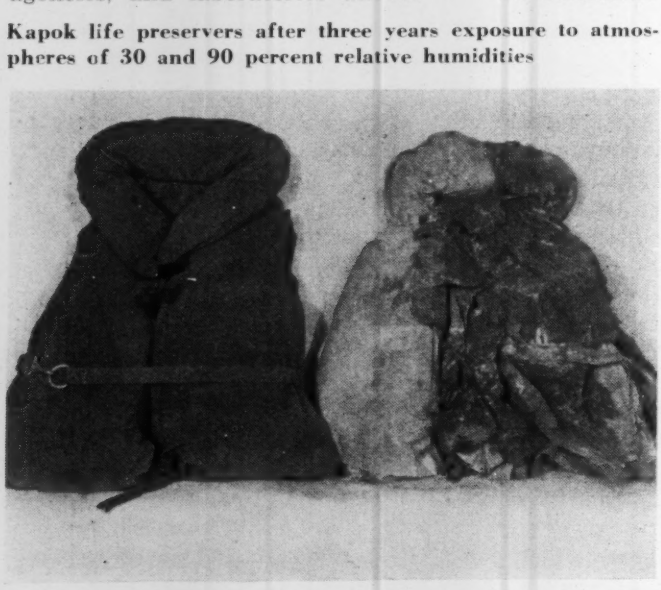
Is it essential to control humidity to insure long time preservation? Tests made by the bureau of ships and other interested bureaus, agencies, and laboratories answer this question in the affirmative. No preservative material has yet been found which will maintain an item of equipment normally subject to deterioration by corrosion or mold in a state of readiness for immediate use and at the same time withstand the vicissitudes of cycling the equipment through the dry bulb temperatures at which condensation occurs. Items of equipment preserved with the best known preservatives and exposed to uncontrolled atmosphere have been observed to have deteriorated beyond the point of possibility of repair for use after as little as 90 day exposure. A group of vessels not belonging to the Navy, which, on being placed out of service, were laid up using preservative coatings alone, have recently been returned to service. These vessels required overhaul of virtually all operating components before they were usable. While costs may not be presented here, it may be stated that costs were many times those of placing in service similar ships which had been dehumidified for equal periods. The potential cost in manpower chargeable to inadequate preservation in the event of a required sudden mobilization and which might otherwise be applied to production in other fields is apparent.

Is it necessary that relative humidity of 30 percent be maintained? As a corollary to this, is there a critical relative humidity below which deterioration will not occur and above which deterioration is rapid?

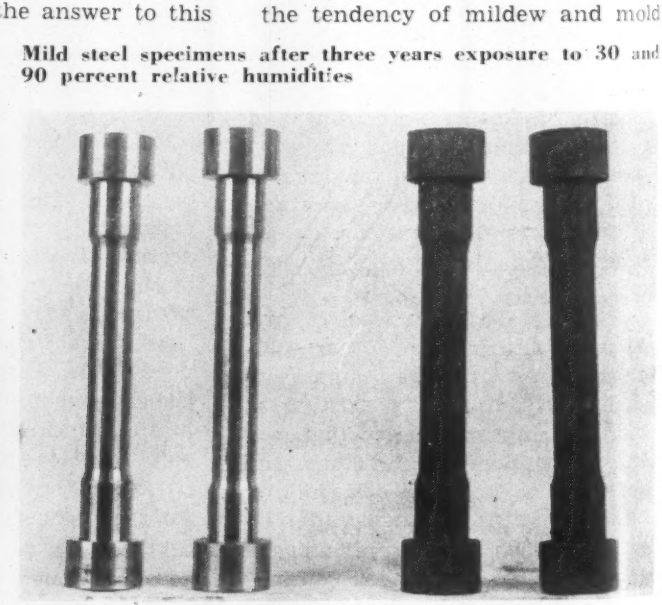
To determine the answer to this and other questions, the bureau of ships established a test project in which a series of spaces are kept at fixed relative humidities in increments from 15 percent to 90 percent. To parallel conditions which would exist aboard ship, dry bulb temperatures are not controlled. No effort is made to prevent the infiltration of dust or to control the presence of potentially corrosive gases other than water vapor since this would not be done aboard ship. In each of the spaces are placed samples of virtually all basic materials used in ship construction and in the ship's equipment and outfit. Additionally, such samples of operating equipment as can practicably be placed in the spaces are made a part of the test. Materials with and without preservative coatings are exposed. At regular intervals all items are inspected and where essential, are subjected to tests to determine physical properties and performance characteristics.

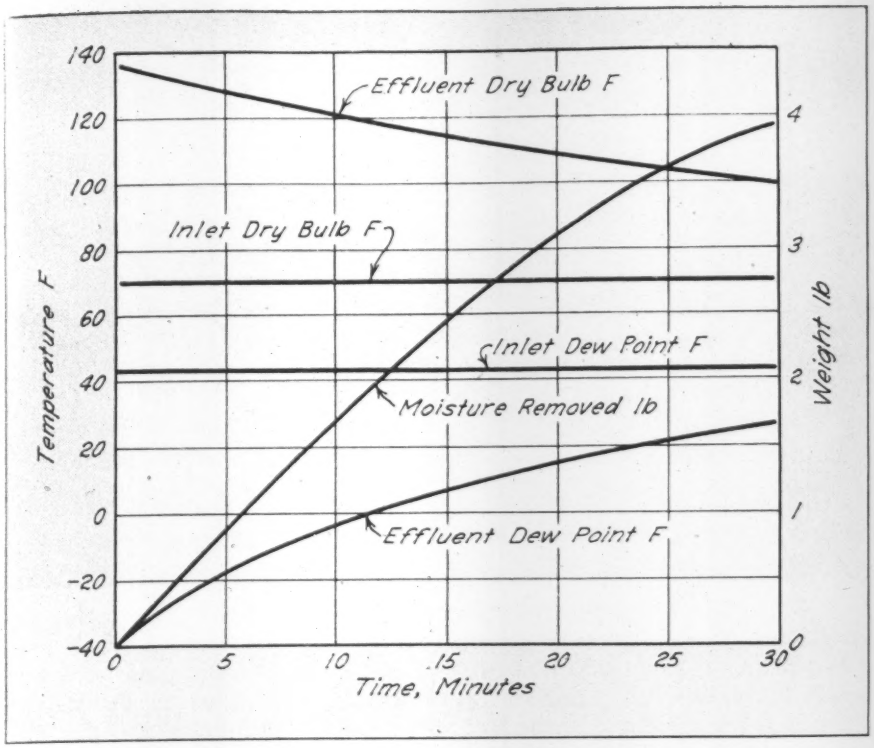
From evidence to date, it may be stated that with other conditions uncontrolled, there is no critical or break point of relative humidity. It may be further stated that a relative humidity of 30 percent will so inhibit the formation of corrosion, mildew, and mold as to make possible the estimate that, for practical purposes, such formation is prevented. As humidity is increased to approximately 60 percent relative, there is but small increase in the tendency toward deterioration by corrosion. There is, however, a more definite increase in the tendency of mildew and mold

Kapok life preservers after three years exposure to atmospheres of 30 and 90 percent relative humidities



Mild steel specimens after three years exposure to 30 and 90 percent relative humidities





Typical performance characteristics of a large dehumidifier, adsorption cycle. Entering air at 70 F and 35 percent relative humidity

to form on animal and vegetable materials. At 90 percent humidity, all materials subject to deterioration rapidly deteriorate with or without preservative coating. It may be concluded that, with other factors uncontrolled and for purposes of practicable application, a critical relative humidity does not exist but that one of approximately 30 percent will prevent deterioration.

Does Control Stop Active Corrosion?

What happens when corrosion is active at the time dehumidification is applied? Evidence to date reveals that, at 30 percent relative humidity, corrosion stops. As time passes, the rust film becomes so dry that the light powdery residue may be brushed off with ease.

Since the deterioration of materials is prevented by maintaining an atmosphere of low relative humidity, why is it essential that preservative coatings be used at all? If equipment is opened up to permit that it rapidly come in equilibrium with the 30 percent atmosphere, manifestly that equipment is not ready for immediate operation. Further it is not practicable to open some equipment at all. If not opened up, the time for complex interior surfaces to reach an equilibrium of 30 percent relative humidity is considerable. This period required for machinery to reach equilibrium conditions inside and out is sufficiently long that the item in question will deteriorate past the point of operability unless additional preservation measures are taken. For equipment essentially open to the atmosphere, no preservative measures additional to the control of relative humidity are necessary.

It having been established that the use of preservative coatings additional to the maintenance of a dehumidified atmosphere is essential under certain circumstances and the reason for this being that just presented, is it established that equipment of this nature is in fact adequately preserved for periods indefinitely long? As a part of the test project mentioned earlier, various complex units of machinery were inactivated, using preservative films of such nature that they did not impair the immediate readiness of the equipment to operate without removal of preservatives. The items were then placed in an atmosphere of 30 percent humidity. At intervals varying from six months to three years of no further attention, these equipments have been started and found to function as designed. They have then been torn down and minutely inspected for evidence of deterioration. None has been observed.

Similarly, the trial reactivation of a limited number of dehumidified ships has revealed that all equipment functioned normally where cleaning and necessary application of preservative films had been accomplished at the time of inactivation. Additionally, detailed inspections of representative items of equipment on board ships inactivated for a period from six months to over two years have revealed that the items have not deteriorated.

The ships are for practicable purposes sealed against entry of air. Is there not a probability that oxygen depletion or formation of toxic or explosive gases will make the ships dangerous to enter for necessary inspections? These factors have been carefully observed on representative ships during the time they have been in inactive status. All evidence to date points to the fact that there is absolutely no cause for concern in the premises. On the contrary, the desiccant beds of the dehumidifiers adsorb many vapors other than water on the drying cycle and release them to the weather on the reactivation cycle. There is, if anything, a tendency to reduce the quantities of objectionable vapors.

Since many materials normally attractive to vermin and other

Table 1—Capacity Characteristics of Dehumidifiers used in Reserve Fleet Preservation Program.

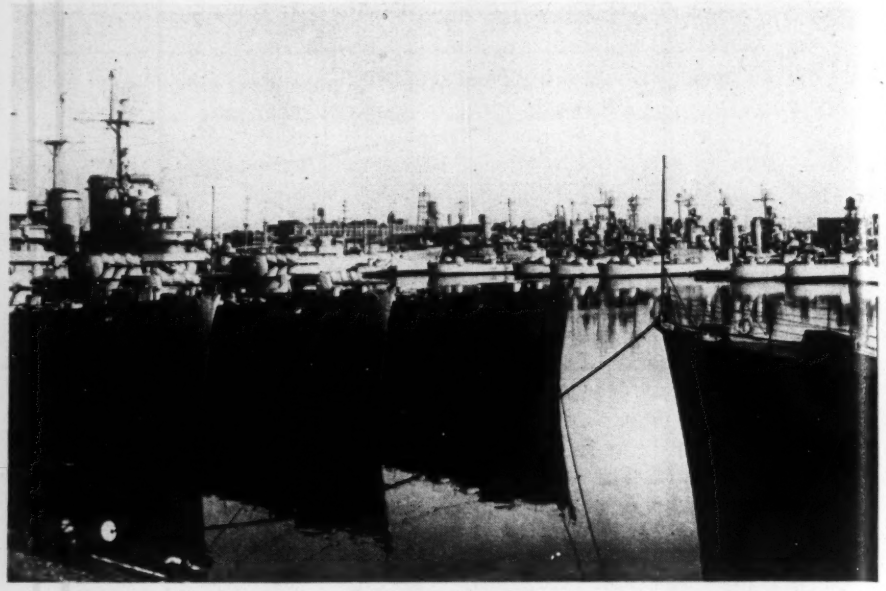
		Package	Large	Medium	Small
Adsorption Air CFM		20	500	250	150
Connected Load KW		1	8	4.6	3
Max. Cu Ft Volume of Shipboard Space Maintained at 30% RH		10000	400000	220000	150000
Adsorption Capacity	95 F 35% RH	0.225	9.4	4.7	2.9
Pounds water per hour	70 F 35% RH	0.210	7.6	4.0	2.4

forms of animal life are retained on board, might it not be expected that some inactive ships will become infested and that these materials will be destroyed? While not so immediate in its effect as fumigation, dehumidification is just as deadly to this animal life over the long period. There simply is no water on which the animal may subsist. As a consequence, the dehumidified ship is entirely free of vermin and none seek to get aboard. This fact has been spectacularly apparent on some ships.

Might not spaces well be dehumidified by static means instead of by resorting to automatic machinery? The average water removed per month from a zone of a typical surface ship has been approximately 525 lb. The zone has a volume of 150,000 cu ft. Assuming that the statically used desiccant is to be changed once each month, and assuming the use of materials of high adsorptive capacity, the charge of desiccant for the zone would have to be approximately 2625 lb. This desiccant necessarily must be distributed throughout the zone. For a frequency of change established at one month, the capital investment in desiccant material alone approximates that of the automatic dehumidifiers in use. If the frequency of change were to be at longer intervals, this investment would soon exceed the cost of automatic equipment. Labor required to effect the changes of a statically used drying agent is to be compared to the approximate total of one man day per month required for the routine maintenance of the automatic equipment installed and for the inspection and recording of conditions within the zone.

The additional moisture required to be removed from the zone incident to its opening to remove and replace desiccant has not been considered in this comparison. This load would materially increase the static charge required over that here shown to be essential. Power costs for reactivating would equal or exceed those for reactivating desiccants within the dehumidifiers since the machines operate at a high efficiency in this respect.

It is apparent, that on a comparative basis, the cost of static dehumidification is prohibitively high. Static dehumidification provides a valuable and efficacious means of limiting moisture vapor content of the air when the container is hermetically sealed and is a perfect moisture vapor barrier. These requisite conditions are not generally encountered aboard ship. Static dehumidification is used to a limited extent in the reserve fleet program. Its application is limited to spaces which may be sealed and which do not lend themselves to incorporation in the dry air distribution system from the installed machines.



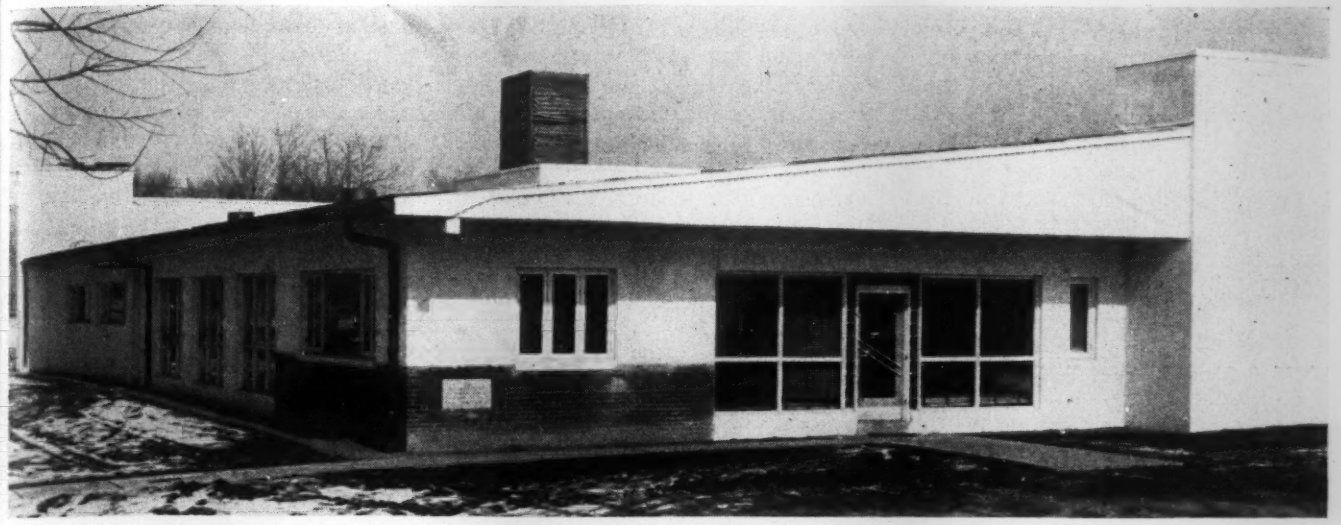
These ships are protected by dehumidification

Is Low Humidity Harmful?

Finally, is it not possible that the low relative humidity conditions will of themselves directly destroy certain materials? All basic materials have been carefully observed with this in mind. No deterioration of any material attributable to low humidity has been observed. Certain materials, after reaching equilibrium at very low humidities, must be allowed to regain their normal moisture content before they show normal properties. This regain is very rapid. It should be borne in mind that 30 percent is not an extremely low humidity, but is one normally encountered in heated office spaces and homes during the winter season.

The general appearance of a ship laid up in accordance with the principles herein presented is impressively excellent. The interiors parallel in appearance those of a ship just delivered from the builder and awaiting the appearance of her crew. The odor is that of a clean, fresh atmosphere, having no remote relationship to the musty odor ordinarily associated with spaces long unused. The appearance has been described as that of a ship whose crew has just left for light refreshments and which was scheduled to and capable of getting underway on a moment's notice.

A most careful detailed inspection of components reveals that this general appearance is not deceptive. The equipment is found to be in the same condition in which it was left many months before, and in a state of complete readiness for use. The author was intimately associated with the reactivation of a number of destroyers and submarines of the "Red Lead Fleet," just prior to this nation's entry into the recently concluded hostilities. His most vivid recollection of that period is associated with the fact that for many months his epidermis was covered with a mixture of grease and rust that defied removal by the most powerful of solvents. As of this date, it must be concluded that the principles of preservation established for the maintenance of the reserve fleet are sound and that dehumidification provides an eminently satisfactory solution to the problem of long-time maintenance of ships in an excellent state of preservation and immediate readiness.



Condensing is normally by tower water, although city water can be used under control of a condensing water regulating valve

Refrigeration Piping and Control for Locker and Processing Plant

LAST OCTOBER—at the end of a year's construction period—the Williamson County Cooperative Service opened a large locker and processing plant in Marion, Ill. Its capacity of about 1700 lockers classes it as one of the larger plants of the state, and the completeness of its facilities, with the accent on packing and processing plant layout, makes this plant of particular interest.

The purpose of this article is to describe the layout of the refrigeration piping and control systems, since these are necessarily quite complex to serve the varied applications.

JOHN H. CARTER, partner, Bodine & Carter, engineers, Webster Groves, Mo., describes the piping and control features of a 1700 locker and processing plant, which are necessarily quite complex to serve the varied applications. Requirements of the various spaces in such an installation are classified and discussed

Sizes of the rooms and the capacities of the refrigerating equipment are not necessarily proportioned for a typical locker plant of 1700 total capacity, since there is a good deal of custom slaughtering and chilling, wholesale freezing of fruits and vegetables, and bulk storage of frozen foods, beyond normal locker plant requirements.

Temperatures Required in Refrigerated Rooms

Temperature requirements of the refrigerated rooms are:

Locker room:	0 F, plus or minus 2 F.
Freezer:	—18 F, plus or minus 3 F.
Bulk storages:	0 F, plus or minus 2 F.
Chill room:	35 F, plus or minus 2 F.
Aging room:	34 F, plus or minus 1 F.
Curing room	40 F, plus or minus 1 F.
Curing pump room:	41 F, plus or minus 2 F.
Cured meat storage:	41 F, plus or minus 2 F.
Hide and offal holding:	35 F, plus or minus 2 F.

The locker room and the two bulk storages, the chill, the aging, and the curing rooms must be maintained at high humidities. At a future time, when daily pickup service is available for hides and offal and when the present bulk storages are filled with lockers, it is intended to convert the present hide and offal room to a 0 F bulk storage—its cork and low side are sized for such future application, and the suction piping connections and the control layout are arranged so that the load can then be carried by the compressor which serves the 0 F rooms.

The various loads are served as follows:

The curing room, and the cured meat storage and pumping room, are handled by a double cylinder 2⅞ in. x 2¼ in. ammonia compressor with 3 hp motor. It is desirable to use a small compressor especially for these loads, for the sake of close temperature regulation and high humidity in the curing room.

The chill room, the aging room, and at present the hide and offal room, are handled by a double cylinder 3½ in. x 3½ in. compressor, with 7½ hp motor. The aging room, which has very little refrigeration load but which has a high humidity requirement, is equipped with oversize low side capacity for the sake of a close temperature difference between room air temperature and

refrigerant suction temperature.

The locker room and the two adjacent bulk storages (and later the present hide and offal storage after its conversion to bulk storage) are handled by a double cylinder 5½ in. x 5½ in. compressor, with 15 hp motor. The low sides in these rooms total 5528 ft of full weight black steel 1¼ in. pipe coil. This use of about 3 ft of 1¼ in. coil per locker capacity allows the compressor to operate at a suction pressure of 4 or 5 lb gage or higher, thus assuring a high relative humidity in these storages.

The freezer, which contains 2880 ft of 1¼ in. FWBS pipe coil, is handled by a four cylinder 3½ in. x 3½ in. compressor, with 10 hp motor.

Piping and Control Cross-Connected

The above arrangements represent the normal operating layout. In case of removal of any compressor or driving motor for repair, its loads can be transferred to another compressor, since both the piping and the control layout are planned for such cross-connection. Similarly, either condenser can be repaired, and either condensing water pump can be removed in emergency, without seriously affecting plant operation except under the worst periods of load with conditions of high wet bulb.

Condensing is normally by tower water, although city water can be used under control of a condensing water regulating valve. The 125 gpm atmospheric spray type cooling tower is located on the roof of the slaughter section (the high point of the building) and its pan discharges the cooled water into a large open tank hung just under the roof, at which point the city water make up float valve is also located to guard against freezing in coldest weather.

Low Side Comprises Six Coil Assemblies

Considering the locker room and the two adjacent bulk storages as one room held at a uniform temperature (there are three thermostats in these spaces all controlling one liquid solenoid valve), there are six coil assemblies each served by one thermal expansion valve, each assembly being individually piped for hot gas defrosting. Each thermal expansion valve is installed with shutoff valves and flanges before and after, so that any valve can be replaced or repaired with negligible interruption to operation of the room.

By dividing the low side into six coil circuits it is possible to defrost each coil circuit with an ample supply of high pressure gas (from the entire refrigerating plant), and to dilute the wet suction from that particular coil circuit with the normal suction gas from the other five coil circuits going to that compressor, so that the final wet suction condition at the compressor is minimized. The generous proportioning of the locker room low sides holds down the accumulation of frost (as does also the use of air locks at locker room entrances), to an extent that indicates the need of defrosting at intervals of not less than one year. Defrosting of only one-sixth at a time should have practically no effect on the temperature of the locker room and the adjacent bulk storages.

Another reason for dividing the locker room low side into six coil circuits is that any coil circuit can be pumped out and its ammonia liquid stored in the receiver in case of need. The removal from service of one or even two coil circuits for repair would not seriously affect temperatures in the space.

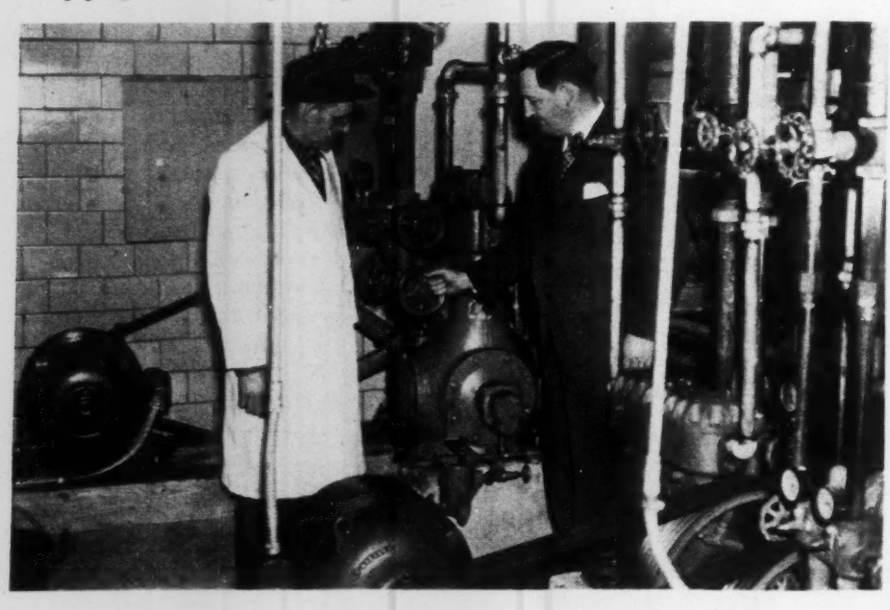
Freezer Low Side Has Four Circuits

The freezer low side is divided into four equal coil circuits, each with its thermal expansion valve, and each piped for hot gas defrosting. The entire freezer is controlled by one thermostat and liquid solenoid valve. Although normal operation calls for a freezer air temperature of from —15 F to —21 F, the baskets of packaged products are in contact with the shelf coils, which means a faster freezing than would be otherwise encountered in still air at that temperature range.

The low side and compressor capacities are capable of maintaining an air temperature in the freezer of —30 F, in case increasing freezer loads should ever require stepping up freezing capacity. In addition, the air in the freezer can be agitated by means of one or two blowers in order to wipe the upper surfaces of the packages with fast-moving air, again in case increasing loads require this step-up of capacity. Air agitation is considered preferable to lowered air temperature, since it allows the compressor to operate at an economical higher suction pressure to accomplish the same freezing work.

The chill, aging, and various curing rooms are refrigerated by forced circulation unit coolers, with direct expansion ammonia under control of thermal expansion valves, each room having its liquid solenoid valve under control of a room thermostat. In case these high suction loads must be transferred to a low suction machine during

Romeo Garavaglia, manager of the locker plant, and the author inspect some of the piping in the refrigerating machinery room



The freezer low side is divided into four equal coil circuits, each with its thermal expansion valve and each piped for hot gas defrosting

repair periods, there is a suction pressure regulating valve in the cross-connection in the machine room, adjusted so that suction pressure for these high suction low sides will not go below 30 lb gage pressure.

The only unit coolers which require defrosting are those serving the chill room. During periods of heavy loading, these units require a short daily defrosting period. This is done by breaking the electrical circuit to the liquid solenoid valve, by means of unscrewing the fuse in that circuit.

Keeping Oil Out of Low Sides

In any low temperature refrigerating plant, it is important that no oil be allowed to get into the low temperature low sides. The hot gas defrosting method can be used to warm up any such oil trapped in the coils and let it be pulled back with the suction gas, but it is preferable to make sure that the oil does not get into the coils in the first place. For this reason, a large high pressure oil separator is used in the discharge line common to all four compressors, before the discharge flows into the two shell and tube condensers and into the receiver. Hot gas for defrosting is taken off after this oil separator, similarly to guard against any chance of oil reaching the low sides.

The control hookup is such that, when any room thermostat calls for refrigeration, the corresponding compressor will start, and a tower pump will operate. In the case of the large compressor serving the locker room and the bulk storages, the entire series of six low side coil circuits will be activated by the one solenoid valve, to insure that the full capacity of the compressor suction will not be confined to a fraction of the low side.

Bodine & Carter, Webster Groves, Mo. made preliminary studies of layouts and costs and acted throughout the project as consulting engineers. Frank L. Thompson, Kirkwood, Mo., and W. V. Wuellner, Alton, Ill., were associate architects. The general contractor was H. E. Mitchell Construction Co., Harrisburg, Ill. The refrigeration contractor was Burge Ice Machine Co., Chicago, the insulation contractor was the United Cork Co., St. Louis.

TELLS BENEFITS OF PIPING STANDARDS

How the national standardization program carried out by the Manufacturers Standardization Society of the Valve and Fittings Industry, the technical organization in this field, has helped to reduce the cost of production and cut down the investment in special patterns, tools, jigs, and fixtures was described by Lester Benoit, general secretary of the society, in Industrial Standardization, published by the American Standards Association. Where formerly volumes of paper work and blueprints passed between the manufacturers and the consumer to make certain that the product would be made to the correct dimension now, through the use of standards, manufacturers can produce in economical quantity runs and consumers can place orders confident that the material will be the right size, will fit the design requirements, and will assemble with products made by other reputable manufacturers, Mr. Benoit said.

As an example of the effect that a simple standard may have on making business transactions easier, Mr. Benoit referred to the MSS drain tapping standard, SP-28. Through its use, the location of bosses on pipe fittings and valves and the nomenclature used in designating these bosses are standardized. Use of the standard makes it possible to order the proper location and size of tapping on pipes and fittings in simple terminology and with no chance of confusion. Formerly it had been necessary to provide blueprints to prevent mistakes.

Marking System Identifies Product

An important feature of the MSS standardization program is the marking system which identifies the product as to construction, indicates quality, and assures the safe use of the pipe. This is important in the piping of such dangerous fluids as high pressure or high temperature steam, lethal gases, and hazardous chemicals. The marking system has prevented the unsafe use of valves and resulting loss of life and damage to property due to improper and unsafe use of piping materials.

What Are the Right Air Conditions for

COMFORT COOLING?

Hospitals in Tropics Carry Uniform Temperatures and Relative Humidities Throughout the Season

EARLY THIS year, J. F. L. Grocott—of the Anglo-Iranian Oil Co., Ltd.—made an extensive visit to the United States in connection with his studies of air conditioning in the tropics. Just before he sailed he presented before the Institution of Heating and Ventilating Engineers, at a special meeting held in London, one of the most interesting papers that has appeared in the journal of the institution for some time. It occupies almost the whole of the Vol. 16, No. 153 issue, and because the experiences of this well-known company in comfort cooling in Iran are thought likely to be of interest to many who may not see the IHVE journal, the highlights of this paper are reviewed below. Engineers interested in air conditioning in the tropics would do well to study the complete paper carefully. For all air conditioning engineers and hospital people it contains much of value and some conclusions that bear close study.

"The great civilizations of the past in China, Persia, Syria, Egypt, Greece, and Italy are, or were," the author commences, "all situated on a rather narrow belt of equable temperature with an annual mean dry bulb of about 70 F with a maximum around 100 F and a minimum of 40 F. Anything in the way of a major departure from these temperatures seems to have had a retarding influence on mental development; the business of living was apparently so difficult that there was no time for philosophy, etc."

The birth and present development of air conditioning, Mr. Grocott suggests, are mainly due to the changed working, living, and playing conditions accompanying the industrial revolution. "As inaccessible and inhospitable areas of the world were opened up and occupied by the white races, and as industrial pressure developed, plant, machinery, records, routine, etc., required attention the day 'round and the noonday heat required to be endured. Equipment for comfort cooling, developed as a luxury for the affluent, trickled into the tropics to keep men fit on the job or provide relief and relaxation from trying, if not necessarily unhealthy, conditions. . . . There is now a vast immediate and potential market for suitable equipment."

CYRIL TASKER reviews and summarizes here a most interesting paper on comfort cooling in the tropics which was presented recently by J. F. L. Grocott, of the Anglo-Iranian Oil Co., Ltd., before the Institution of Heating and Ventilating Engineers in London. Data on the temperatures and humidities which have been found comfortable in various buildings—particularly hospitals—are especially valuable, Mr. Tasker stresses

Climate and the Outside Design Conditions

Unfortunately for the air conditioning engineer, there is very little information on wet bulb temperatures in most of the available weather data for the tropics. The use of the maximum dry bulb temperature ever recorded as a basis for air conditioning design is uneconomic, and the average maximum is unsatisfactory. The author suggests that the design dry bulb shall be that temperature which is not exceeded more than 60 hr or 5 percent of the total cooling hours in a season, whichever is less. *The question of outside design condition is of some importance as its effect on the capital investment is appreciable and it is essential to design on a competitive basis.* [Italics are C.T.'s]

Comfort Conditions and Inside Design Temperatures

In view of recent suggestions on air conditioning for health, the following statements are of interest. "What constitutes a condition of comfort and whether this condition is necessarily healthy still remain in doubt due to the complexities of

mental reactions and the lack of a really representative yardstick. Dry bulb temperature, relative humidity, air velocity and direction, and mean radiant temperature due to enclosing surfaces, which are all capable of more or less accurate measurement, are influential factors, but age, sex, body surface area, clothing, ability to perspire, general condition of health, degree of activity, acclimatization, and mental reactions are equally important and mostly impossible of resolution. There are very many independent variables peculiar to man and the environment which beset a universally applicable scientific solution. Laboratory data provided by a limited number of subjects performing artificial tasks in a controlled atmosphere with a specialized preparation routine in a rather monotonous sequence and all extremely conscious of being tested, provide considerable physiological data, but do not appear to measure up to a completely practical solution.

"It is apparent that the results of field tests require reviewing with some reserve as they are conducted with many variables active which would otherwise be stable in a laboratory investigation. However, it does appear that from mass opinion some determination, which at least can be construed as comfort, is possible and in the tropics something more definite than has hitherto been available is required. Whether conditions deduced from mass analysis are ultimately healthy is another question and the onus of proof seems to rest with the medical scientists. I suggest it is a more reasonable approach to the determination of comfort conditions by using the popular vote and mass analysis in the field which establishes a condition satisfactory to the buyer or user and then to examine this from the point of view of health by clinical observation and laboratory tests rather than to proceed in the reverse order. This is not a dangerous procedure as the reduction of temperatures has been a steady process over a number of years.

"In 1935 the effects of low inside temperatures were uncertain but a scale of inside dry bulbs to suit the prevailing outside dry bulbs and a tentative comfort zone was prepared by the staff of the Anglo-Iranian Oil Co. in Iran and added to the standard American Society of Heating and Ventilating Engineers chart reproduced here."

Mr. Grocott reported that considerable operating experience had been gained by his company since the original design recommendations were made, and "since 1935 the maximum inside dry bulb temperature has progressively dropped until any temperature above 85 F dry bulb (77.5 deg effective temperature) is now considered to be outside the comfort zone and an inside range of 75 F to 83 F covers an external range of from 90 F to 125 F. This scale has also been added to the chart.

Temperatures and Humidities for Hospitals

"This range is used as the basis of all comfort cooling design in staff housing, etc. and all buildings except the general hospital, where the medical staff have some 10 years experience of complete air conditioning. They demand a uniform condition of 75 F and 50 percent relative humidity (70 deg ET) under all summer outside conditions for general wards, treatment rooms, etc., and 70 F and 30-50 percent RH (65-66 deg ET) for winter conditions. In the operating theaters, 70 F and 50 percent RH (66 deg ET) is demanded all the year 'round, although the annual external range is 40 F to 120 F.

"These conditions may appear alarming when it is understood that medical personnel are exposed to the external and internal conditions many times a day at irregular intervals, but the experience of 10 years is that no ill effects have been noted and very considerable benefits have resulted in the treatment and improved recovery time of patients. There has also been noted a marked reduction in the incidence of sepsis. At the time these temperatures were introduced there was some doubt, and comprehensive and careful clinical observations were made before their acceptance as a standard.

"Temperature shock in either direction seems to create discomfort for a short interval . . . but unless one is in a poor state of health no injury results. The main reaction when leaving a cooled building to outside conditions is an appreciation of the comfort just lost.

"Parallel with the experiences of relatively low inside dry bulbs, equipment introduced into buildings in Iran followed in the wake of self-contained direct expansion (American) room coolers. These had no elaborate features for humidity control and the relative humidity cycled about almost as it liked. There were no complaints about this providing the relative humidity did not get too high, consequently central air cooling plants for multiroom buildings were reduced to their simplest terms and the dehumidifying chilled water coil [is used]; in effect they were a reproduction of the room cooler to a larger scale.

"It was observed that cycling of the dry bulb temperature did not have a noticeable effect on the comfort sensations providing the dry bulb did not exceed the tolerable maximum. Indeed it can be said to be a possible asset, as the maintenance of a constant condition seems to induce a feeling of deadness and it is so unlike natural air conditions."

"Summing up, our experience is that for summer comfort in the high temperature tropics—

a) 85 F is the maximum inside dry bulb (77.5 deg ET).

b) 75-83 F is the summer range of inside dry bulb (70 to 77 deg ET).

c) Relative humidity shall be a maximum of 60 percent.

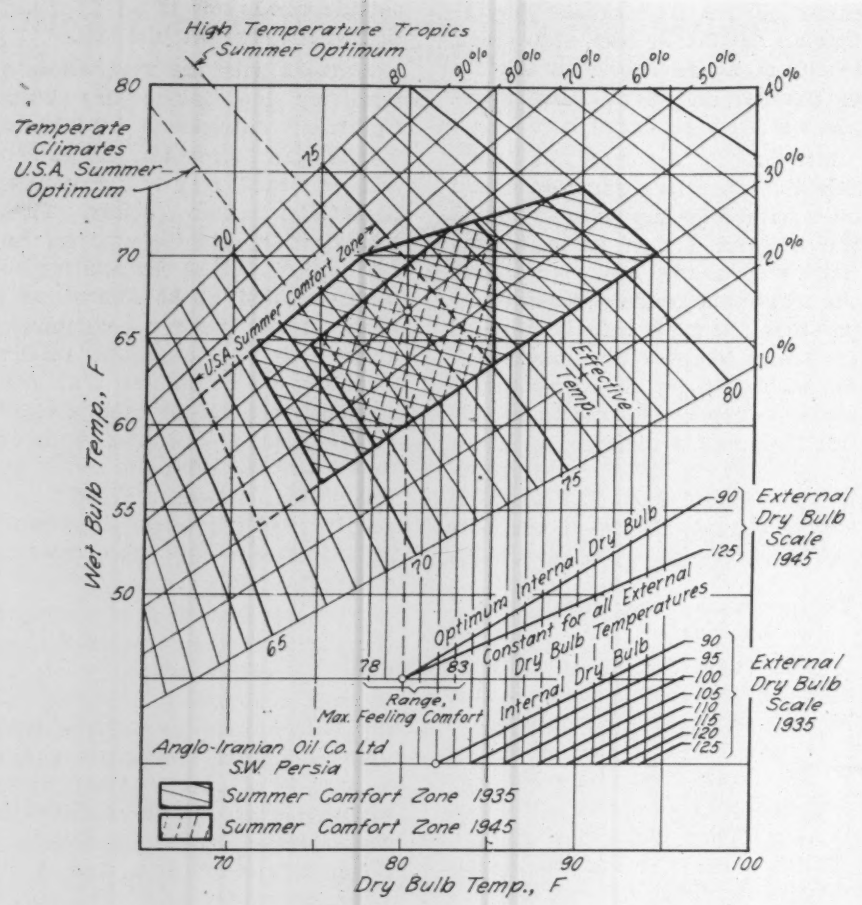
d) Relative humidity may cycle between 25 percent and 50 percent providing the dry bulb temperature is right.

e) The dry bulb temperature may cycle through about 6 F without being noticeable.

f) For winter comfort, a dry bulb temperature of 70 F with relative humidity as required by (d) is acceptable."

Influence of Building Construction

To obtain an endurable level of temperature in the Middle East and India if the building is not provided with air cooling, massive construction (18 in. thick walls as a minimum), flat roofs (often 8 in. or more thick), and high ceilings are all used. In relatively modern


High Temperature Tropics
Summer Optimum
Temperate Climates U.S.A. Summer Optimum
U.S.A. Summer Comfort Zone
Effective Temp.
Wet Bulb Temp., F
Dry Bulb Temp., F
Optimum Internal Dry Bulb
Constant for all External Dry Bulb Temperatures
Internal Dry Bulb
External Dry Bulb Scale 1945
External Dry Bulb Scale 1935
Range, Max. Feeling Comfort
Anglo-Iranian Oil Co. Ltd S.W. Persia
Summer Comfort Zone 1935
Summer Comfort Zone 1945

ASHVE type of comfort chart, showing comfort zone for high temperatures

housing, a generous proportion of shaded glass and French windows is used. Verandas, canopies, and venetian slats are extensively used to reduce the effects of direct sunlight to a minimum. Buildings are finished in light colors and roofs are often whitewashed. Though in modern housing developments both walls and roofs are of lighter construction, ceiling heights remain at 10 to 14 ft.

In general, Mr. Grocott reports, the estimated cooling load for buildings in the tropics is higher than the actual; this is unfortunate for it often results in the rejection of schemes. "The reasons for the error are, given a proper estimation of the external design condition, to be found in the doubtful data concerning the thermal properties of the local materials and construction and the influence of solar radiation." [Similar reasons can be given for errors in estimates in the U. S. Some of the most important studies in the present ASHVE research program were specifically planned to provide facts instead of guesses for cooling load estimates.—C.T.]

"Of the various properties of a building fabric or construction which influence the cooling load, perhaps the most important is its heat capacity and ability to reflect solar radiation. The value of high thermal capacity lies in the reduction of the peak load and its deferment in time. Walls constructed from different materials but with the same total conductivity, external face absorptivity, and internal face emissivity will transmit the same quantity of heat in 24 hr, when exposed to the same diurnal air temperature and solar radiation cycle. The internal face temperature of the wall with low heat capacity, however, will more nearly follow the outside temperature and will be higher at some times and lower at other times than the high heat capacity wall. The capacity of the cooling equipment for a low heat capacity structure will therefore require to be correspondingly greater. . . . An example of heat capacity carried to the limit occurs in the Pyramids which are of such a capacity compared to the enclosed space that it is alleged the annual seasonal temperature variations are cancelled out and the inside air temperature is constant the year 'round."

Mr. Grocott stresses the need for further information on the influence of building construction and solar radiation on the periodic heat flow to the conditioned space.

Cooling Methods Employ Refrigeration

In the tropics, comfort cooling is generally effected by refrigeration since neither air movement alone nor evaporative cooling can provide comfort in most tropical locations.

If it is agreed, Mr. Grocott says, that very precise control of dry bulb temperature is unnecessary, (a tolerance of 6 F being permissible) and that there need be no control of relative humidity except for the imposition of a limiting value of 60 percent, a comfort cooling and warming installation, reduced to its simplest terms, will consist of a filter followed by a dehumidifying cooling coil using chilled water (and capable of providing heating through the same pipe system, fan, and duct distribution system and automatic controls.) Many successful installations of this type have been made in the Middle and Far East.

Discussing the application of surface air cooling in this type of plant, Mr. Grocott says that "most comfort cooling applications for offices, homes, clubs, libraries, and similar building types have a sensible/total heat ratio between 0.75 and 0.95 and the majority fall in the 0.85 to 0.9 category. They can, therefore, with a little exercise of trial and error, be fitted into a simple coil case. All that has to be borne in mind is that it is not possible to fix arbitrarily both the supply air volume and condition—if one is fixed the other is complementary and either may be found unsuitable to the application. It is easiest to fix a supply air condition from an examination of the possible coil conditions on the SH/TH line having regard to the fact that a leaving air condition in the range of 75 to 95 percent saturation is practical and the middle to end of this range desirable. Having chosen

such a supply air condition, the air quantity can be calculated and examined from the point of view of suitability with regard to distribution, air movement, and supply air to room air temperature differential. Once the initial case conditions and air quantity are fixed it is necessary to examine the result of using the same air quantity at the condition available from the coil under the remaining sets of possible conditions. It may require a few approximations but experience will reduce the labor and the simplicity of the resulting plant is worthwhile."

800 Ton Heat Pump Plant

Mr. Grocott gives information on self-contained equipment used by his company in comfort cooling systems (2000 installations in all) and discusses some of the advantages and disadvantages of various types. Interesting details are also given of the method of application of house coolers in Adaban with the layout of mains to carry chilled water at 50 F, returning at 58 F in summer, and warm water at 125 F, returning at 117 F in winter. An 800 ton ammonia system was installed for this service, and it is arranged for operation as a heat pump for winter warming.

It is perhaps of interest to note that in the very lively discussion that followed the presentation of the paper some stress was laid on the desirability of a moderate amount of temperature cycling to avoid the monotony of a closely controlled atmosphere.

The ASHVE research programs in solar radiation and periodic heat flow came in for special mention, it being suggested that similar data might be developed for other latitudes than 40 deg north.

Better Bidding Forms Reduce Costs

Improvement of bidding forms as one method of holding down construction costs was urged upon the American Society of Civil Engineers at its summer convention in Seattle.

R. B. Rothschild, Jr., of the San Francisco contracting firm of Haas & Rothschild, called upon the engineers to prepare better bidding forms as their contribution toward creating a better meeting of minds between owners and contractors.

"The wording and manner of presenting a bid form have an important significance in determining the ultimate cost of the job to the owner and assuring a reasonable profit to the contractor," Mr. Rothschild declared. "When a contractor is preparing a bid which is obviously very risky, he will naturally try to figure on the safe side. He will often provide for contingencies in his bid to take care of construction difficulties which might be expected but which, in all probability, will not occur. Thus, when a specification is set up with a bid form which tends to throw the burden of unforeseen elements on the contractor, the chances are that the owner will pay not only for the contingencies which do occur, but also for some which do not. The intelligent answer would seem to be to set up a manner of bidding which allows the contractor to be paid just for contingencies which do occur and can be evaluated, but not for those which are purely problematic.

"It has been the sad history of the construction business that when a contractor bids on a job too low, everybody concerned suffers," he said. "This contractor will unconsciously take unnecessary risks which might prove very costly, and he might even cut down on the quality of his work. If he loses too much money, the bonding company will have to take over the job, the program will be greatly delayed, and the engineer and the owner will be put to a lot of unnecessary trouble and expense.

"The unit bid form is the most expedient way of arriving at a solution on heavy construction and other types of projects where the hazards are of great consequence. However, in the past, many unit bid forms have lost sight of their purpose and become merely a mathematical nightmare for the contractor instead of reducing his hazards," he concluded.

1947 SAFETY RECORD SHOWS IMPROVEMENT

Industry closed its books on 1947 with a better safety record than the year before, according to the National Safety Council.

The 1947 industrial injury rates, released in advance of the 1948 edition of Accident Facts, the council's annual statistical yearbook, show that the overall accident picture is improving.

The accident frequency rate for all industries submitting company reports to the council, based on the number of disabling injuries per 1,000,000 man-hours, was 13.26 in 1947, a reduction of 10 percent from the year before.

The communications industry again had the lowest frequency rate, leading all other industries last year with a rate of 2.98, a 10 percent reduction from 1946. The second place industry was electrical equipment, with a frequency rate of 6.02, down 21 percent from 1946 when it placed sixth.

At the other end of the list, coal mining climbed up one step from the bottom position as the result of 7 percent reduction. Its 1947 rate of 54.46 was better than the lumbering industry which had the highest 1947 frequency rate of 59.74. Lumbering was second highest in 1946.

The accident severity rate for all industries reporting to the council, based on the number of days lost per 1000 man-hours, was 1.23 in 1947, a reduction of 7 percent from the year before.

Communications again led all other industries with the lowest severity rate. Its 1947 rate was 0.16, a reduction of 24 percent from the previous year. Wholesale and retail trade ranked second last year with a rate of 0.17, moving up from its fifth place standing in 1946.

Coal mining stayed at the bottom of the list again, with the highest accident severity rate of 7.96, but that was a 27 percent reduction from the rate in 1946. Mining, other than coal, had the second highest rate both years, 6.58 in 1946 and 6.17 last year.

New Underground Steam Piping Decreases Line Pressure Drop

It was necessary at one point to go through a jeweler's vault under a sidewalk with a 14 in. line

E. J. FLAHIE, engineer with the Toledo Edison Co., briefly describes — and illustrates — construction details of the new underground steam piping recently installed to meet increased demands for purchased steam service. With the additional station outlet and lateral lines looping together the main feeders, pressure drop has been decreased and more uniform pressure distribution can be maintained. Sections of the piping can now be isolated for making new connections and for maintenance

Since 1944 there has been a rapid growth of business on the Toledo Edison Co.'s steam heating system, the number of customers increasing 100 percent. Recently, 90 customers of a former company made application for service and it became necessary to provide additional capacity and another outlet from the heating station.

The system was designed to supply the entire downtown business district from a single source, the Water St. station, which can serve a rectangular section of 32 blocks. The distribution system begins with two 14 in. feeders, one from each end of the station. These extend about 1500 ft, then reduce to 12 in. and form a perimeter for most of the district. Lateral lines 8 in. in size connect the feeders at each street intersection.

The maximum capacity of the system is 500,000 lb per hr. When first put in operation, there was one 14 in. outlet from the station and two lateral lines, one 12 in. and one 8 in. As the demand for purchased steam service increased the lateral lines were extended until there is approximately 23,000 ft of piping in service.

The 1947 extension consisted of 14, 12, and 8 in. lines for a total length of 3000 ft. It was constructed by the A. Bentley and Sons Co., engineers and contractors, using prefabricated pipe units with fiber glass insulation. The first two sections of the line extend 850 ft from the plant, and were designed for 250 psi and 500 F; the remainder was designed for 250 psi and 400 F.

The pipe conduit is corrugated ingot iron, wrapped with a triple covering of asphalt-saturated asbestos felt. The conduit for the 14 in. pipe is 10 ga, for the 12 in., 12 ga, and for the 8 in., 16 ga. The conduit has the standard covering of asphalt about 3/16 in. over the top of the corrugations.

A part of the steam main is subject to flood conditions. No manholes were constructed in this section, the expansion of the main in this case being taken care of by loops—except for one expansion joint in a waterproof manhole.

Avoiding Obstructions

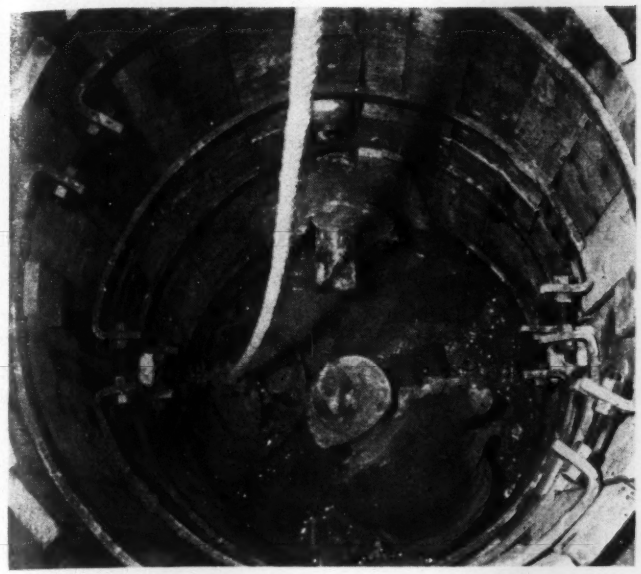
On city property the main is located in the sidewalk or street, depending upon the obstructions. Many obstructions in the streets were overcome by the steam line being placed 7 to 9 ft below grade. Where the main crosses or is adjacent to other conduits, insulating concrete was placed as a barrier.

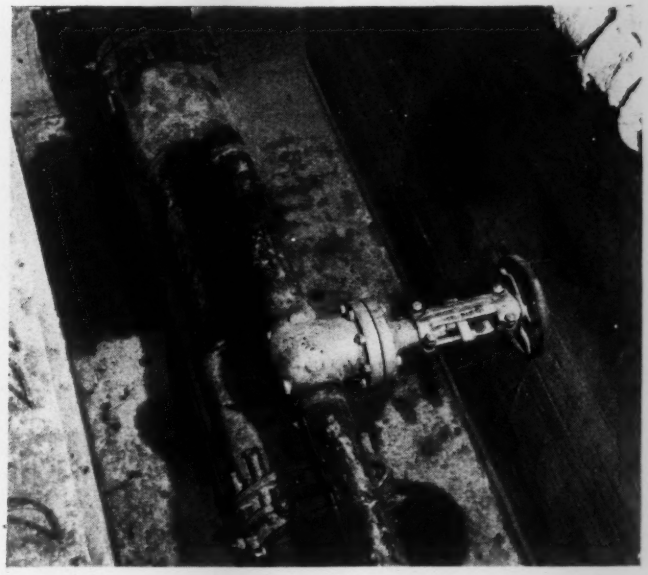
Anchors are located in manholes, ends of loops, between manholes, and at direction changes of the main.

Most street crossings were made by excavating part way and tunneling the balance. The excavated portion was bridged with ½ in. steel plates, 6 ft square. Traffic was maintained while constructing such street crossings.

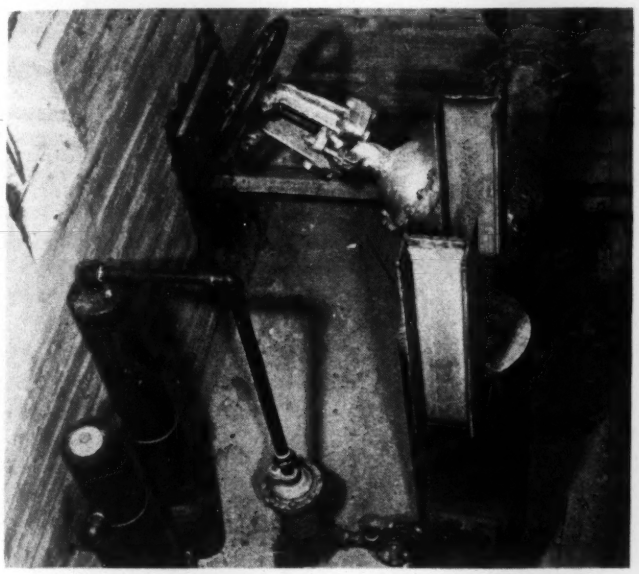
The manholes are reinforced concrete and are located in the street or sidewalk. Each manhole has two 30 in. openings with double covers. They are equipped with a cast iron P-trap and a drain to the sewer. Provision was made in the manhole walls for future services and lateral line connections.

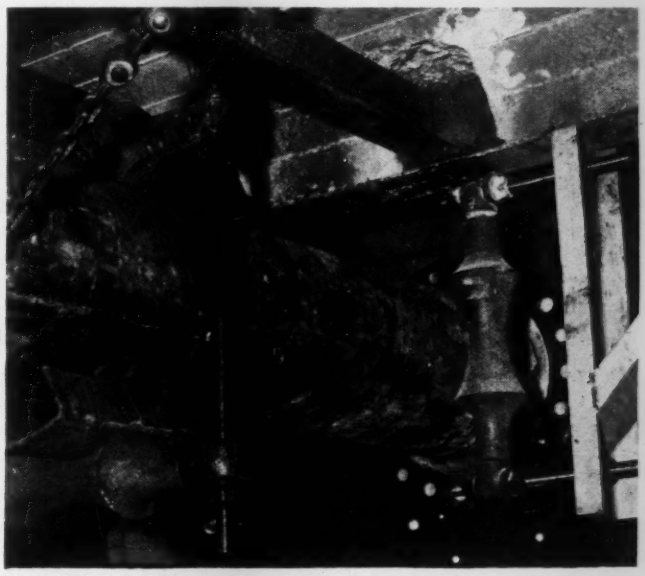
The structural steel in the manholes was thoroughly cleaned and given a coat of rust inhibiting paint, followed by a coat of red lead and oil paint, then a final coat of asphalt



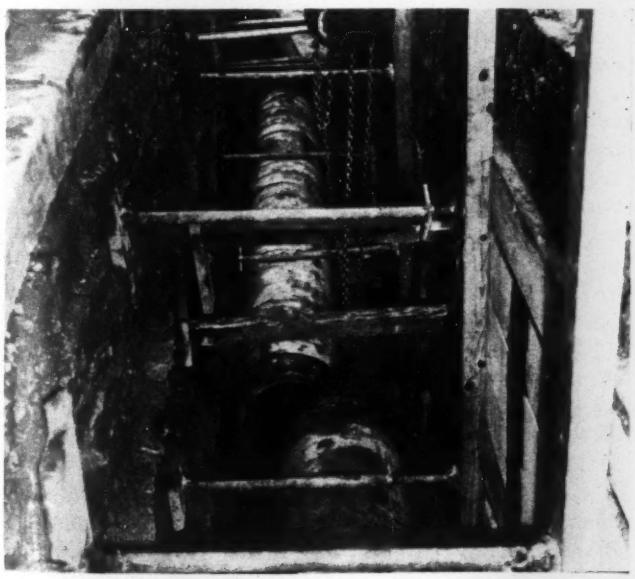


Left: Excavating for a sewer connection for a manhole Right: Expansion joint manhole with a 4 in. service connection





Left: Manhole on an 8 in. line Right: Guide ahead of an expansion joint in the 14 in. line in the plant



Left: Prefabricated pipe units for a 14 in. line with a 9 ft trench Right: The pipe conduit joints were tested with air

Left: Applying soap solution on conduit connector band seams during the air pressure test. Right: This photo shows insulation on an expansion joint, and the 4/0 copper wire connection for preventing electrolytic corrosion

base paint. Where steel plates were secured to the manhole walls, an extra heavy mastic was applied.

The expansion joints are the gun packed type, welded, single end, with anchor base, and designed for 300 psi. The valves on the 14 and 12 in. lines were flanged, since welded ends in these sizes could not be obtained.

The prefabricated pipe units consist of 21 ft. seamless steel pipe, schedule 30 for the 14 and 12 in. lines and schedule 40 for the 8 in. The pipe was insulated with blanket fiber glass, electric welded, and tested to 400 psi before expansion joints were installed. The pipe and conduit were welded while the pipe units were in the trench, usually a section between manholes. The ends of the conduit have a waterproof preseal ring to keep the insulation dry until closure of the joint. The end seals remain permanently in place. Bell holes were made at conduit joints to facilitate welding. The conduit joints were tested with air at 15 psi.

The pipe, expansion joints, and valves in the manholes were insulated with 3 in. of fiber glass sectional pipe covering, bound with straps on 6 in. centers. A membrane fabric was wrapped around the covering and a waterproof material spread on to a ¼ in. thickness.

Preventing Electrolytic Corrosion

No. 4/0 copper wire was connected around the expansion joints, also to the conduit, and the pipe was bonded to a neutral bus in the plant. The purpose of the wire around the expansion joints and the connection to the conduit is to prevent electrolytic corrosion. In the area served by the steam system there are several streets that have car tracks carrying negative return current from a railway direct current system. The steam pipe and conduit are separated in the manholes and any stray currents which might get on the pipe or conduit are conducted by the wire. Electrolysis occurs where current leaves the pipe; therefore, if it can be conducted by wire or pipe, no corrosion will occur.

In conclusion, with the additional station outlet and three lateral lines looping together the main feeders, the pressure drop has been decreased and a more uniform distribution pressure can be maintained. Certain sections can now be isolated for connecting services and for maintenance with a minimum amount of interruption, and provision is made for future expansion.

[Photos by V. E. Morris, photographer, Toledo Edison Co.]

Plans Floating Vehicular Tunnel

A floating steel and concrete tunnel nearly three miles long, to bear four lanes of vehicular traffic, estimated at 10,000,000 cars annually, is "the only type of structure possible" to link Seattle with the 5400 square miles on the Olympic Peninsula across Puget Sound, Charles E. Andrew, chief consulting engineer, Washington Toll Bridge Authority, declared in a paper read at the summer convention of the American Society of Civil Engineers at Seattle.

Upward lift of the tube, the top of which would be 50 ft below the water's surface, would be resisted by live load anchors weighing 500 to 600 tons each and resting on soft bottom material in water depths as great as 800 ft, Mr. Andrew said. He described construction methods contemplated, detailing how water would be admitted into sections as finished to sink them to the desired depths, and told of 30,000 ton floating fenders to be used in guarding against ship collision with the ventilating towers.

Mr. Andrew invited suggestions and criticisms from his colleagues in the ASCE. He asserted "the type of structure is rather bold and presents many new problems in design, yet the general principles are relatively simple. As far as water is concerned, it is probably the most dependable of all foundation materials, provided all its laws of action, which are definitely known, are adhered to."

HIGH PRESSURE HOT WATER

Boiler Types and Piping Connections

J. R. KELL, partner in the firm of Oscar Faber & Partners, consulting engineers, London, England, devotes his discussion of HPHW this month to the types of boilers commonly employed, the piping for the flow and return water and the boiler feed, the boiler fittings required, etc. In the April and June issues, he covered fundamentals of high pressure hot water for process and space heating, pipe sizing, design, and piping layout

IN GENERAL, it may be said that any type of boiler suitable for steam raising, may be used for high pressure hot water heating, provided it is designed for the pressure of operation decided upon.

Types in common use in England may be classified as follows:

Vertical cross tube—Up to 5 million Btu per hr per boiler.

Horizontal shell type with fire tubes—5 to 15 million Btu per hr per boiler.

High velocity water tube—10 to 30 million Btu per hr per boiler.

Other types have also been used, but special reference need not be made to them here.

Fig. 1, of a vertical cross tube boiler, shows the method of connecting the flow and return pipes, this being the chief point of difference between a boiler for HPHW and one for steam.

Fig. 2 shows a horizontal shell type boiler arranged for HPHW, the flow connection being taken at a point away from the crowns of the flues, so as to avoid, as far as possible, the entrainment of steam bubbles with the water.

In both Figs. 1 and 2, it will be noted that the flow and return connections take the form of dip pipes, terminating a short distance below low water level, and the return is not brought in at the bottom of the boiler. This is to prevent the boiler being emptied in the event of a serious leakage from the system.

A further point to note in boilers of this type is that as the water of expansion is to be accommodated in the steam space, longer gage glasses than usual are sometimes fitted.

Where two or more boilers are to be connected together in battery form, it is necessary to keep all water levels at a common line, and for this purpose steam and water balance pipes are arranged, as in Fig. 3. The sizing of balance pipes is empirical, and may be taken as follows:

Millions of Btu boiler rating	Size of balance pipe, in.
2.5	3
5	4
10	5
15	6
20	7
30	8

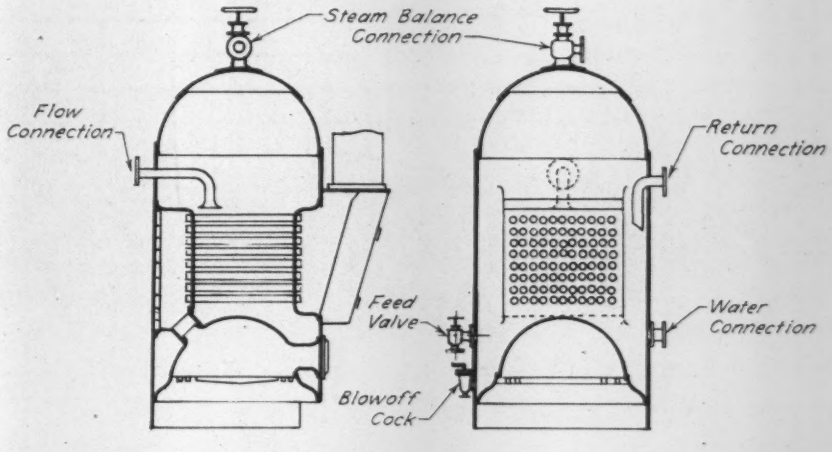
Fig. 4 shows a boiler of the high velocity tubular type. In this case, a separate drum is used to provide the steam space with sufficient capacity to accommodate the water of expansion. The return water from the system enters the boiler via the return header, passes through the banks of small bore tubes into the flow header, and thence to the drum, which is usually fixed at high level above the boiler.

Where two or more boilers are required, they are connected in parallel to the same drum. If the size of the installation calls for two drums, these are coupled together with steam and water balance pipes, as in the case of shell boilers. The complete boiler house piping arrangement with a battery of these boilers connected to a single drum is shown in Fig. 5.

Mixing Return Water with Flow

The necessity for mixing return water with the flow to prevent ebullition has already been referred to. This chiefly applies where shell type boilers are used, where there is in-

Fig. 1—Vertical cross tube boiler for high pressure hot water heating, showing the method of connecting the flow and return pipes



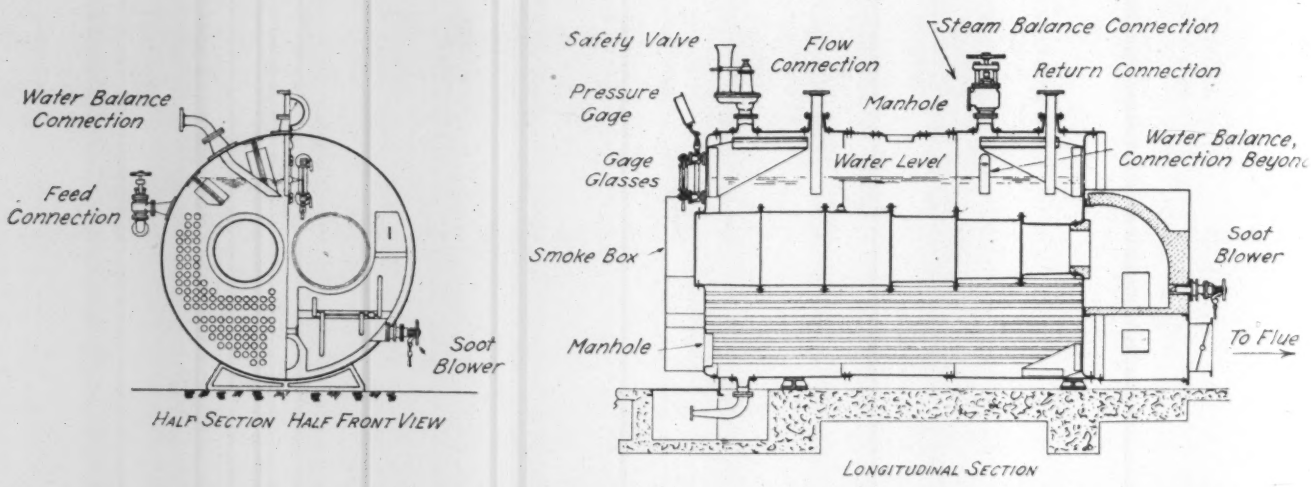


Fig. 2—Horizontal shell type boiler arranged for HPHW system, the flow connection being taken at a point away from the crowns of the flues to avoid as much as possible entrainment of steam bubbles with the water

evitably a vertical uptake, and some length of horizontal run between the boiler and the pump suction, causing drop of pressure.

Where a separate drum is used, as with the tubular type boiler, it is possible to drop directly from the high level drum down to the circulating pumps, so increasing the static head at a greater rate than loss of head due to friction, and rendering mixing for the purpose of preventing steam formation less essential.

Apart from this, however, a main mixing connection directly into the pump suction from the return from the system may be necessary to allow the temperature of the flow to the heating apparatus being varied to suit the weather or for other reasons. The position of the mixing connection can be seen in Figs. 4 and 5.

This mixing pipe must be carefully sized to pass the maximum flow necessary, at the same time avoiding starving the boiler of water.

The mixing valve may be thermostatically controlled, if desired, as by an external weatherstat.

With such an arrangement, the boiler may be run at constant temperature and pressure with a separate pump and piping system serving the process requirements, hot water calorifier, etc. The constant temperature system might be designed for a flow temperature of, say, 10 to 20 deg below saturation temperature, with a small bore mixing connection permanently set to give this reduction. Fig. 5 shows a dual temperature system with three pumps; one heating, one process, and one standby to either.

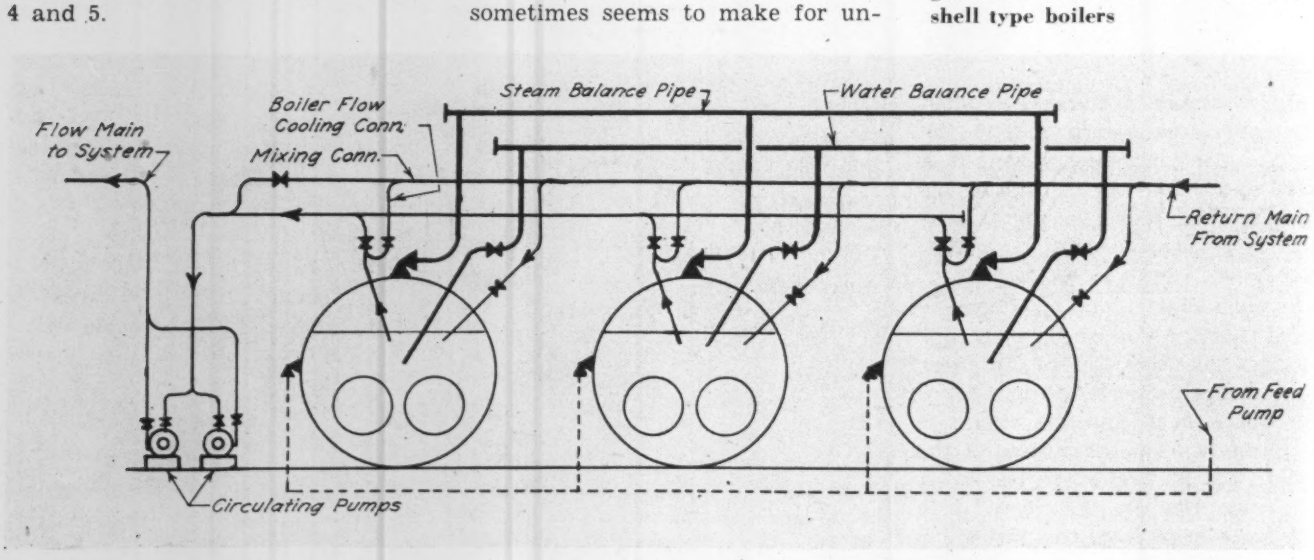
It is as well to bear in mind that hot and cool water do not mix readily, particularly when the hot water is on the point of boiling. The sudden shock of meeting a stream of cooler water in itself sometimes seems to make for unstable conditions, and the release of steam. For this reason, some designers are in the habit of arranging long sparge pipes to effect the mixing; some have a series of mixing cones, while others have nothing at all, yet seem to manage successfully.

With the two streams joining before the pump, the mixture on the discharge will be complete, due to the churning action, which is another reason for installing the pump in the flow.

Sizing the Boiler Feed Pump

Since the make-up feed necessary is that due only to leakage, or the use of steam soot blowers, or safety valve discharge, etc., the quantity of water required is small, generally no more than 1 percent of the

Fig. 3—Where two or more boilers are connected together in battery form, it is necessary to keep all water levels at a common line. This diagram shows steam and water balance pipes and general connections for a battery of shell type boilers



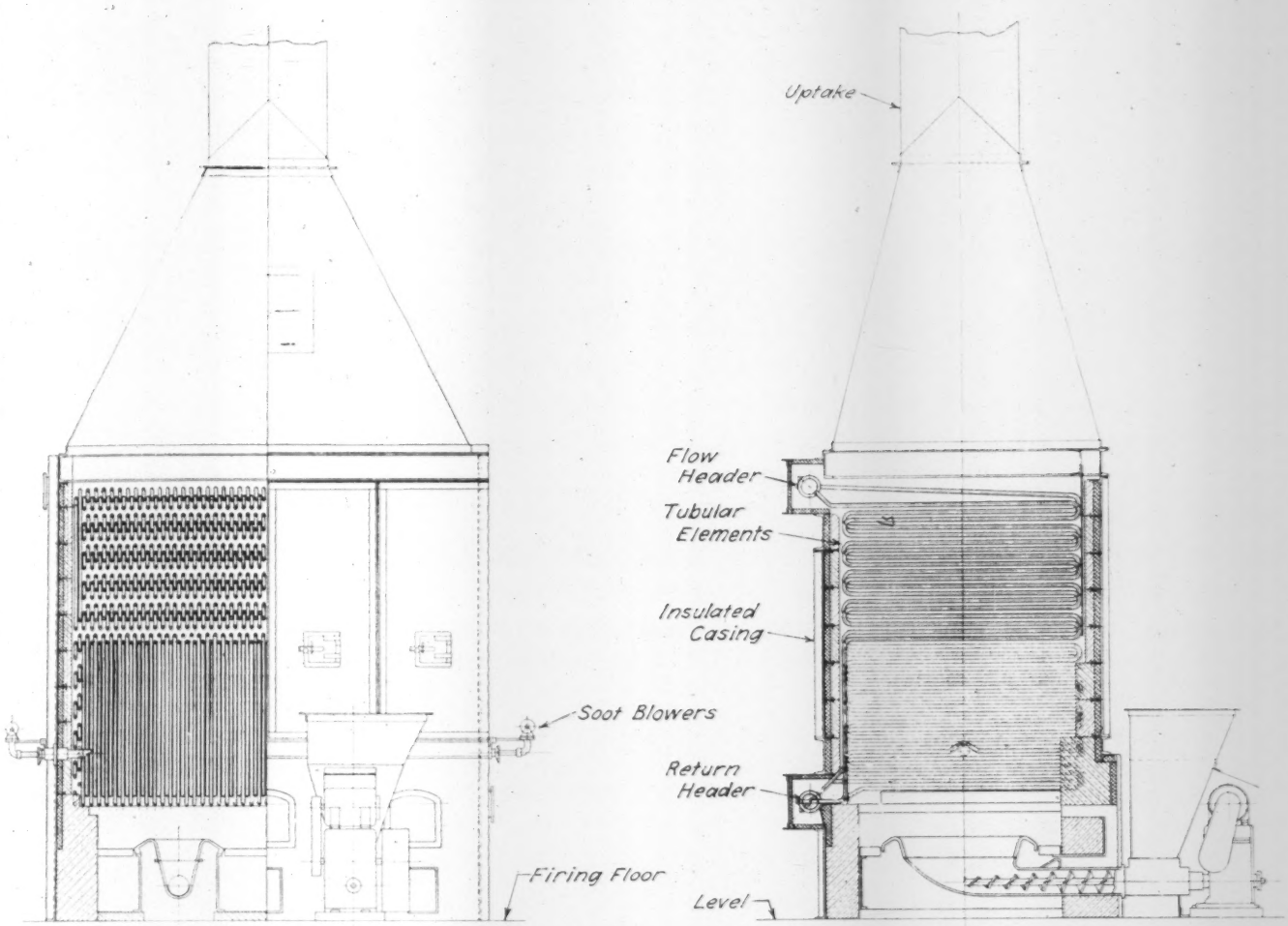


Fig. 4—High velocity tubular type boiler, stoker fired. A separate drum is used to provide the steam space with sufficient capacity to accommodate the water of expansion

equivalent hourly evaporation. Thus, for a boiler of 10 million Btu, the feed might amount to 100 lb per hr.

Nevertheless, it may sometimes be required to recover a fallen water line quickly; say where a section has been emptied and refilled. Thus a better method of sizing the feed pump is to make it equal to the mean-to-maximum expansion capacity in the boiler or drum, allowing perhaps half an hour for this to be recovered. The pump duty per hour will then be twice the expansion in gallons.

The feed tank on which the pump draws will be sized accordingly, on the expansion capacity plus a margin.

The pump will, of course, need to be in duplicate, a useful method being to provide one electrically driven and one steam driven for standby, the steam being taken from the boiler or drum.

The feed arrangement may be as in Fig. 6.

Supposing we are tempted to use the steam from the boiler or drum for numerous purposes other than the barest minimum mentioned above, what is the result?

The system of piping, coils and other parts of the heating apparatus then becomes the receptacle for all the sludge normally left behind in the boiler. This gradually accumulates at points such as the bottom headers of unit heaters, in the cavities of valve bodies, in dip pipes, and so on, eventually causing blockages and other troubles.

Valve spindles and seats are also affected by encrustation and quickly become unworkable.

Frequent blowing down at the boiler is no help, since the deposits collecting elsewhere are unaffected.

The answer to this problem is, first, to take no steam from the system other than the barest minimum, and second, in addition, to install a water treatment plant where the water contains appreciable hardness or other solid content. The treatment plant need be sized to deal with the make-up water only, since the initial fill will cause a negligible deposit. Indeed, it is usual to charge the system from the mains through a double valved connection having a removable short length of pipe between the flanges. The short length is removed after the system has been filled, so as to isolate the system completely from the mains.

It is an attractive idea to take steam from the system, such as for process work, or forced draft steam jets, but it is fraught with too many dangers to be admissible. If steam is wanted, it may be generated at a lower pressure by a steaming calorifier. If it is needed at high pressure, then a separate steam boiler should be installed.

As a further preventive of pipe line corrosion, the feed water may be deaerated.

Meters and Controls

Apart from the usual boiler or drum mountings—such as pressure gages, safety valves, water gages, blowdown cocks, and combustion equipment, including stokers or oil burners and the like—certain special fittings are necessary for HPHW.

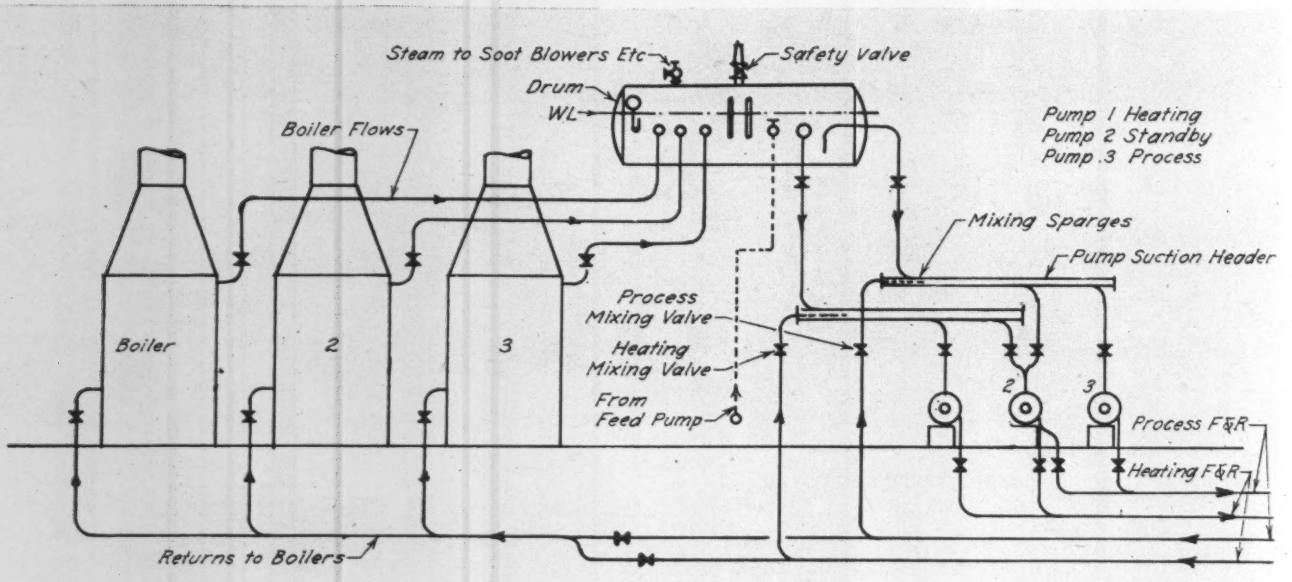


Fig. 5—Where two or more of the boilers shown in Fig. 4 are required, they are connected in parallel with the same drum. This diagram shows the boiler house piping arrangement

Thermometers to indicate flow and return temperature of each boiler, and of the mixed water flow, etc. Certain of these may, with advantage, be recorders.

Flow meter to show the rate of flow in each boiler or through the system as a whole. This combined with temperature differences will afford a useful check on efficiency.

Pressure control device to regulate the rate of firing, so as to maintain constant pressure.

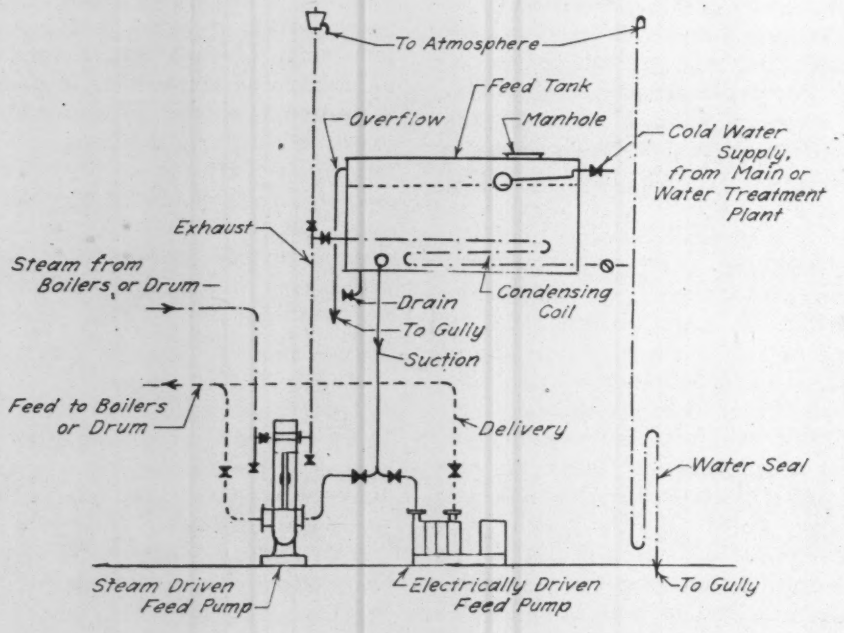
Safety interlock to shut off boiler firing equipment in the event of pump stoppage. This may alternatively be combined with the flow meter which would then have a low limit cutoff.

Automatic water level controller to stop and start the feed pump, or alternatively, to give low level warning by light or bell.

It will be seen that safeguards against pump stoppage are included. Nevertheless, the residual heat contained in the boiler fire and brickwork may be enough to cause trouble if the flow suddenly ceases. With shell type boilers, this may not be serious, as the safety valve can blow, as with an ordinary steam boiler. In the case of the high velocity tubular boiler, however, the water content is so small that the tubes would quickly fill with steam. Even so they may do no more than sag, but starting up may be troublesome, until the system has cooled down and the steam condensed.

A measure worthy of inclusion where it is felt that this occurrence must be further safeguarded is the provision of a steam turbine driven circulating pump, fed by steam from the boiler or drum. Its capacity need not be the full capacity of the main pumps, nor need the steam it uses be considered, since it will be used only in emergency. Such a pump can be got going almost at once if current fails, and it can be run until the boiler has cooled down, or until current is restored.

Fig. 6—Feed arrangement for HPHW boiler installation

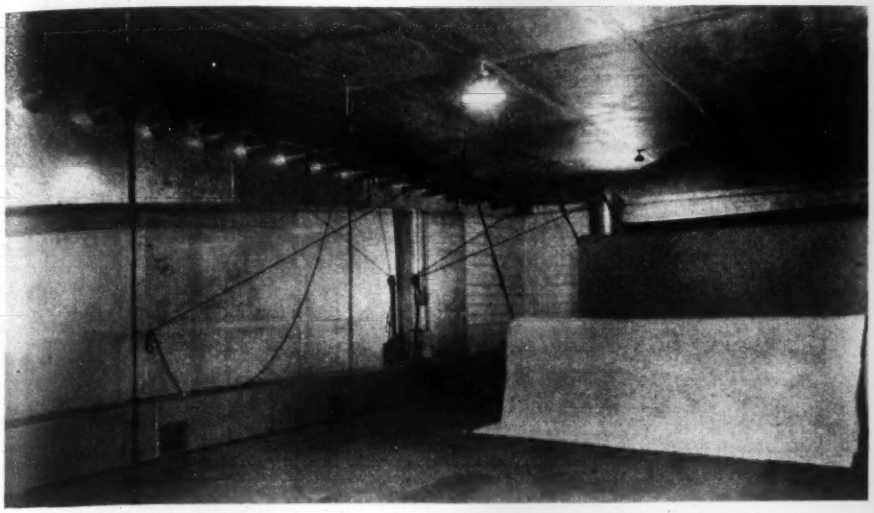


WHICH WAS THE FIRST CONDITIONED FACTORY?

Which was the first factory in the United States to install air conditioning?

This question is being asked by the public relations bureau of the Refrigeration Equipment Manufacturers Association, 3751 Prospect Ave., Cleveland 15, in an effort to discover and recognize the first concerns in this country to have adopted air conditioning.

The association would like information on the date and extent of installations believed to be "first," and a brief description of the type of equipment as well as the present air conditioning program if it has been augmented.



Walls and ceiling of the drying and curing room are heavily insulated and painted aluminum. For curing neoprene base compound applied to the back of carpet, temperature of 200 F is built up in the room by 100 percent recirculation of warm air through the direct fired heater located in an adjoining room. Air is discharged through ports in overhead duct and returned to heater through floor level duct. The latter also is used for exhausting air from the room to the outside

DIRECT FIRED SPACE HEATER SERVES COMFORT, PROCESSING REQUIREMENTS

A SINGLE GAS burning, direct fired space heater, used with a unique system of ductwork, provides six different kinds of heating and ventilating conditions at the Devoncraft Corp., New York carpet finishing plant. The versatile system was designed by M. H. Shorago, vice president and general manager of Devoncraft, which is the finishing plant for Duraloom Carpet Mills, Inc. The system, Mr. Shorago explains, is used for the following:

1) Space heating the entire plant, which contains approximately 12,000 sq ft of floor space.

2) Ventilating the factory during the summer, using 100 percent make up air.

3) Heating 100 percent make up air during the winter for drying neoprene base compound that is applied to the back of loop weave, broadloom, decorator type carpet.

4) Bringing in warm air during the summer for drying the backing compound. (For this operation, only the fans in the heater are used.)

5) Curing the neoprene compound by increasing temperature in the drying and curing room to 200 F.

6) Purging the drying and curing room of heat and fumes after the curing process.

Mr. Shorago reports that operation of the system has proved to be highly successful for drying and curing the carpet backing compound which is a development of the company. Because a temperature of 200 F can be built up in the drying and curing room, processing time is only 2 hr. This system of controlled drying prevents "case-hardening" the neoprene, with the moisture entrapment which would result.

The gas fired heater has a capacity of 500,000 Btu per hr and can handle approximately 5500 cfm of heated or unheated air, discharging it at a velocity of 2000 fpm.

The drying and curing room is 50 ft long, 24 ft wide, and 14 ft high. The ceiling of the room has been built up to form a double dead air space under the cement roof. This was accomplished by installing aluminum insulation along the bottom of the concrete joists, attaching 2 in. x 4 in. nailing strips, followed by a second layer of aluminum foil, and then $\frac{3}{8}$ in. asbestos board. All cracks were sealed and the ceiling was painted with aluminum paint. Cinder block walls on three sides were sealed with a sodium silicate and given a prime coat of paint and a finish coat of aluminum. A partition wall dividing the drying room from an adjoining 28 ft long storage room, where the heater is located, also is doubly insulated and painted aluminum.

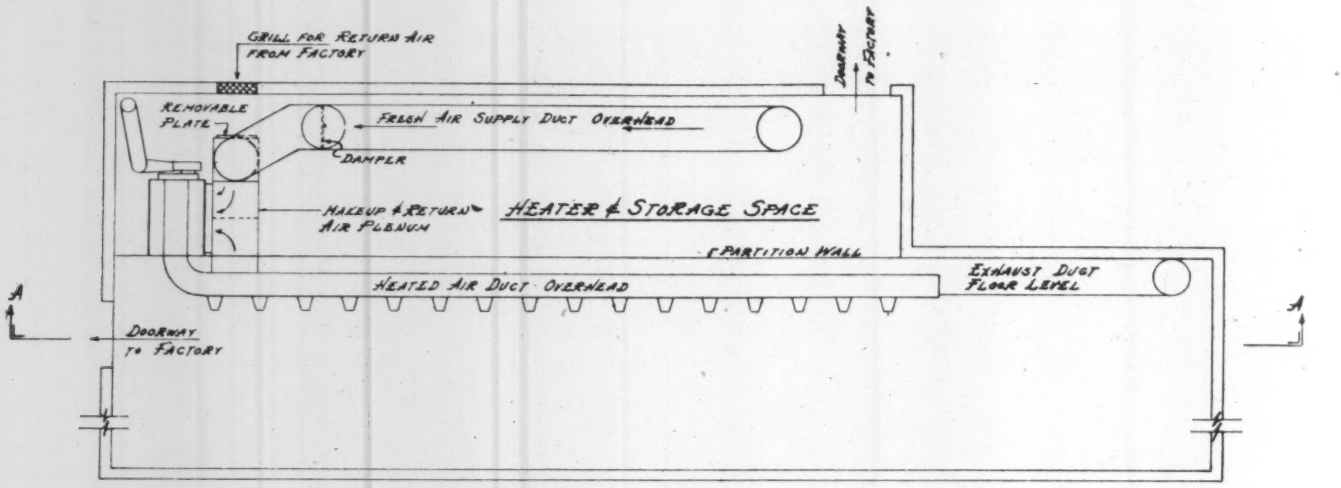
A sheet metal duct 34 ft long extends along one side of the room at ceiling height. It is connected to a small plenum chamber built around the three discharge nozzles on top of the heater. The duct is graduated in size, from 41 in. x 12 in. nearest the plenum chamber to 10 in. x 12 in. at the end to achieve uniform velocity of discharge horizontally across the room. There are 16 discharge ports, each 8 in. long and spaced on 2 ft centers, in the duct.

At floor level, directly below the supply duct, there is another duct 20 in. by 12 in. running the full length of the room. This duct has five inlet grilles, each 10 in. high. Two are 16 in. wide, one 14 in., one 12 in. and one 10 in. The duct is arranged to carry air from the room back to the heater or, when necessary, to exhaust it to the outside through the roof. A 5600 cfm fan is located in the roof exhaust stack. This stack, when open, with fan inoperative, serves to remove a portion of moisture-laden air while permitting partial recirculation.

A 16 in. x 18 in. outside air duct carries make up air into a plenum chamber built at the base of the heater. The return air duct from the drying room empties into the same chamber. One end of the chamber is fitted with a removable plate to provide inlet for air recirculated from the factory during comfort heating periods.

After the Duraloom carpet has been woven, rolls of it are taken into the drying room where the special neoprene backing compound is applied. The carpet then is draped on hangers suspended from the ceiling by a pulley arrangement for drying and curing. About 160 lineal feet of carpet can be processed in one operation. Drying removes moisture from the compound as well as from the carpet.

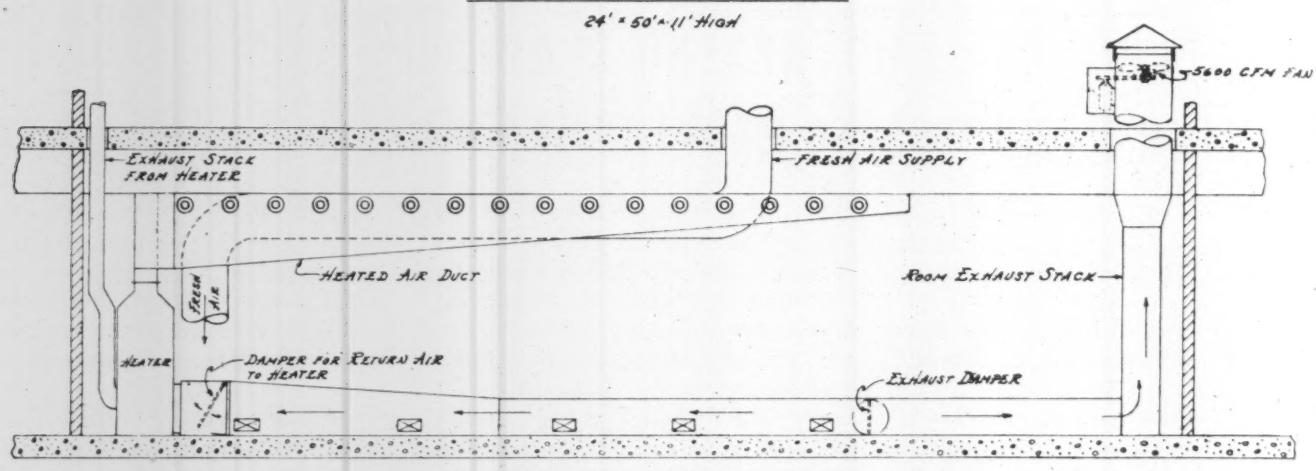
For the drying operation, air is first 100 percent recirculated to take advantage of the better *K* factor of wet carpet, and then 100 percent make up air is used. The re-



PLAN

RUG DRYING & CURING ROOM

24' × 50' × 11' HIGH



SECTIONAL ELEVATION A-A

Here's the installation that serves six different functions

turn air damper in the floor level duct is closed and the damper at the other end of the duct is opened to exhaust all moisture-laden air. The heater has a stainless steel combustion chamber that permits rapid transfer of heat from flame to air, and temperature of the air drawn into the heater is increased about 70 F in a few seconds.

If the outdoor temperature is subzero, however, dampers on the return air duct are adjusted to bleed in a small amount of air from the room. When the desired temperature is reached, all of the moisture-laden air is exhausted.

During the summer, when outside air is hot and dry, only the fans in the heater are operated for the drying process.

For the curing operation, the heater burner is ignited. In curing the neoprene base backing compound, high temperatures are built up gradually within the drying room. All outside air supply is blocked off by closing the damper in the make up air duct. The exhaust air damper also is closed. The heater then is operated on 100 percent recirculated air. This increases temperature in the drying room to 200 F. The heater is designed to raise temperature of the intake air approximately 70 F. Therefore, each time air is recirculated over the combustion chamber of the heater, it picks up additional heat. The cycle continues until the desired temperature of 200 F is reached.

After curing, the room is purged by operating the heater for a short time on 100 percent make up air and 100 percent exhaust.

Comfort Space Heating

For comfort space heating, the unit is operated on 100 percent recirculated air. Heated air flows through ducts into the other rooms. The panel on the make up air plenum chamber in the heater room is removed to aid recirculation. The velocity of return air flow is not high but sufficient quantities of air near floor level are drawn back to the heater to achieve effective space heating.

This unusual system, according to Mr. Shorago, not only has solved the process heating problems, but has established a high degree of comfort in the factory working area. Moreover, fuel consumption is more economical than the previous system which was used for space heating only.

Control of the heater is automatic by means of room air thermostats.

The duct dampers are operated manually since the length of the process heating periods have to be determined by experienced personnel. Mr. Shorago, however, is working on a method to operate the dampers during the drying process by means of humidistats.

[Illustrations courtesy Dravo Corp.]

New Piping and Heating Ideas Reported at the NDHA Meeting

JOHN F. COLLINS, JR., secretary-treasurer of the National District Heating Association, summarizes the reports of the NDHA technical committees and other information given during the 39th annual meeting held in St. Louis, in this article which he prepared exclusively for HPAC. This completes the story of this important meeting, a part of which was presented in July

SIX ASSOCIATION technical committees reported on recent studies on district heating at the annual meeting of the National District Heating Association in St. Louis.

The distribution committee, of which J. J. Collins, New York Steam Corp., is chairman, had papers on four subjects.

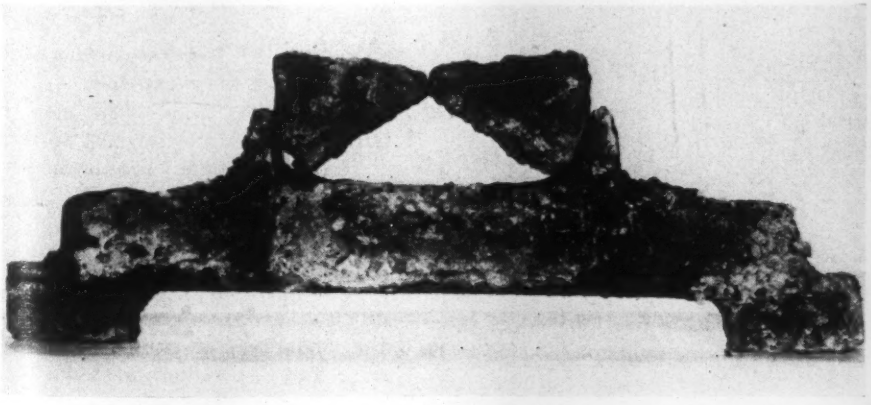
In the first of these, three engineers on the staff of the Detroit Edison Co.—Leo F. Collins, F. J. Schlachter and Glen D. Winans—reported the results of their investigation of corrosion of underground steam line supports. They came to the conclusion that ground water, which they found leaks through concrete conduit from place to place in varying quantities, is responsible for most corrosion troubles, a shorter life for conduit, and a higher distribution expense. They tested 16 metals and found that the chrome nickel types of stainless steel are adequately corrosion resistant and otherwise suitable for pipe supports. Since supports of this higher priced metal of equal strength are lighter in weight, no great additional cost is involved.

Mr. Schlachter had made a further investigation on the customary joints between the sidewalls and base of concrete conduit and in a second paper he recommended the replacement of the old horizontal joint with inner steel form and wooden keyways by a new vertical joint with an inner steel curb form.

A small percentage of the customers of the New York Steam Corp. use steam for space heating only. Service lines for such seasonal customers have had a high maintenance record due to corrosion. Chairman Collins reported that they had decided (1) to build service lines as small as 1 in. where such would serve a new customer adequately, and (2) to make them of copper tubing with brazed joints designed for a nominal working pressure of 200 psi at a maximum temperature of 550 F. Mr. Collins reported that this selection was made because copper is corrosion resistant and can be installed inexpensively.

In the fourth and final paper on the distribution program, J. Bogdonowski, Consolidated Edison Co. of New York, Inc., an affiliate of NYS, described a boring method of installing steam lines. He said that horizontal drilling through sand, gravel, rock, and steel is an accomplished fact even for distances up to 240 ft, and eliminates traffic problems which have added greatly to the cost of steam line construction in congested areas.

Typical failure of bracket and roller on a 16 in. steam main. (Installed in 1928 and removed in 1947)



Drilling Eliminates Traffic Hazards

Of particular interest was his description of the drilling machines found satisfactory and which the utility is having constructed for future use. An air motor using 100 psi air from a standard air compressor turns the drill head. An electric motor may replace the present equipment to eliminate noise. A 75 ton capacity hydraulic jack actuated by an electric powered oil pump capable of developing 10,000 psi advances the caisson and drill. A drilling fluid, instead of the water originally used, is pumped by a special sludge pump through a hollow shaft to the drill head and returns the grindings and chips via the caisson.

Mr. Bogdonowski said the practice is both practical and safe and it reduces the inconvenience to the public caused by traffic diversion, and increases their safety.

Meter Testing Methods Compared

Many have tested shunt flow meters by air, while others have

subjected such meters to steam calibration tests. W. G. Gillim, assistant superintendent of the customer service department of the New York Steam Corp., opened the session on metering by describing each test. He said that the air tests have the advantages (1) that the equipment is relatively simple, (2) that the test laboratory need not be located near a steam generating station, and (3) that the time required is less. On the other hand, the disadvantages are (1) that a more highly paid type of employee is needed to gather the experimental data and compute the results with extreme accuracy and (2) unless the meter is subjected to a static steam or hydrostatic test in an assembled condition, leaks cannot be detected. Regarding the steam tests, he said (1) laymen and regulatory bodies can understand them more easily, (2) mechanical difficulties are readily discovered, and (3) leaks usually are noticeable. The disadvantages are (1) the equipment is bulky and expensive, (2) the use of steam is expensive, and (3) condensing water temperatures, condensate output, and steam demands in large scale testing are too variable to be incorporated in a generating station heat balance.

Since the difference in results by either test is insignificant, Mr. Gillim's conclusion was that the other factors should govern the selection.

A clinic on metering was held following Mr. Gillim's paper. General discussion centered on demand attachments for meters and it appeared that although difficulties were being encountered, several companies are working on improvements, and there is a promise for the near future of better equipment. P. A. Hyde, Ohio Edison Co., Akron, remarked that it was worthwhile to spend enough money to meter properly.

Summer Air Conditioning

One of the great and long standing problems of steam utilities has been their inability to sell all the steam they have the capacity to produce except on extremely cold days. No more ideal customer can be imagined for addition to a steam system than one which would require no steam on the coldest day with a gradually increasing demand reaching the maximum on summer days. The NDHA sales development committee has always been studying ways of improving the load factors of the heating utilities. One of the best means appears to be the addition of summer air conditioning customers using steam for the refrigeration process.

Charles W. Deeg, Philadelphia Electric Co., chairman of the committee this past year, opened the sales development program by calling on George H. Tuttle, Detroit Edison Co., for a report on the latest developments in steam absorption air conditioning.

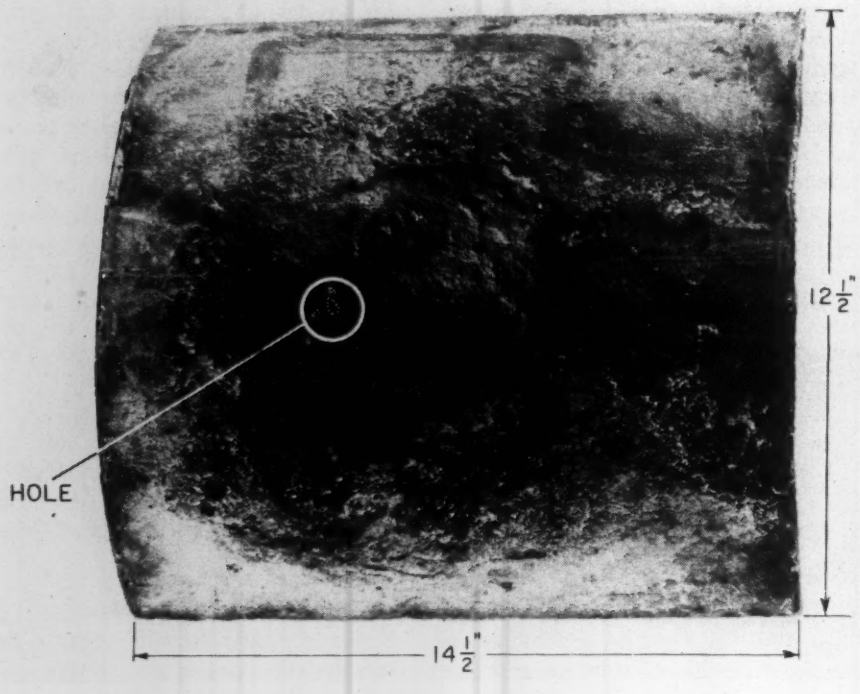
Mr. Tuttle said that one of the advantages of absorption cycle machines is that the equipment operates as efficiently on low pressure steam as on high. Many of the heating utilities have only low pressure steam for sale. Three manufacturers are now making or planning to make absorption cycle equipment. Some of the machines were described.

Mr. Tuttle pointed out that some electric companies having peak hour loads on summer days may welcome a chance to shift the load to the steam system. He voiced the opinion that the customer's cost would be just as low by the absorption cycle as by electric methods.

A customer in Detroit taking steam for space heating, water heating, and pressing, Mr. Tuttle said, had a demand of 1300 lb per hr, an annual steam consumption of 2,247,000 lb, and an annual load factor of 19.7 percent. After a 150 ton steam air conditioning load was added, the demand was still 1300 lb per hr but the consumption became 3,597,900 lb and the annual load factor rose to 31.5 percent.

The importance of securing the summer air conditioning load to heating utilities can be judged from the foregoing.

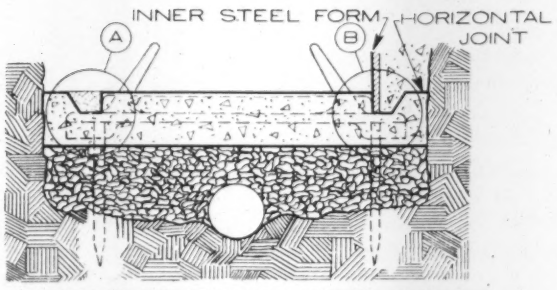
Portion of 16 in. pipe showing corrosion of pipe at the pipe support. (Installed in 1928 and removed in 1947)



Temperature Control

Beginning with a brief review of temperature control equipment of the past, starting with the manual radiator valve, Harry C. Kaysing, Hester-Bradley Co., St. Louis, talked on the characteristics of modern control equipment. He said such systems were designed to give (1) comfort to occupants, (2) steam economy, (3) freedom from service and maintenance expense, and (4) flexibility so that they may be changed at minimum cost to meet changing occupancy requirements.

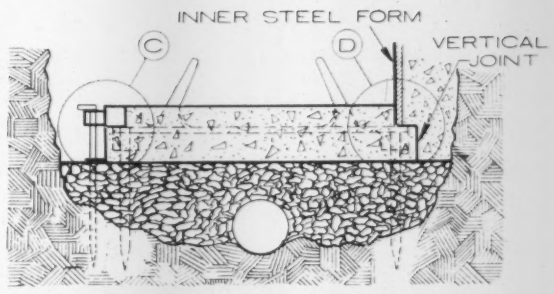
Mr. Kaysing said that, speaking simply, central control efforts may be divided into three broad channels of procedure: (1) the intermittent turning on and off of steam, (2) orificing to balance distribution, and (3) reducing steam tem-



OLD CONSTRUCTION WITH WOOD KEYWAYS

Ⓐ DETAIL SHOWING WOOD KEYWAY IN PLACE

Ⓑ DETAIL WITH KEYWAY REMOVED & STEEL FORM & CONCRETE SIDE WALL IN PLACE



NEW CONSTRUCTION WITH STEEL CURB FORMS

Ⓒ DETAIL SHOWING STEEL CURB FORM IN PLACE

Ⓓ DETAIL WITH CURB FORM REMOVED & STEEL FORM & CONCRETE SIDE WALL IN PLACE

peratures by high vacuum. All three may now be found in a single installation. He concluded by saying he felt that controls should not be entirely automatic but should have some manual features.

"Pavement Pounding"

When A. H. Robinson, Pittsburgh, who has been "pounding pavements" for two decades, got to his feet to present his paper on selling steam he expounded some advice that may well be heeded. He said that the same old problems that perplexed steam people 20 years ago are still unsolved today. The differences that now make selling easier, are due to external conditions; smoke ordinances, actions by labor unions, steel shortages, and the increased price of coal have all "mowed down opposition." He warned that if the utilities are to reach their goal of supplying a popular and low priced heating service, they must prepare for the slump which surely will follow this boom. Salesmen must be prevented from becoming mere order-takers. They must be well supervised and trained again (1) confidently to paint a picture of the benefits of district heating (2) to know how to keep a prospect on the subject, (3) to refute objections without antagonizing, (4) to organize a sales procedure, (5) to prepare a nontechnical report, and (6) to know when to invite the prospect to sign a contract.

A man who has been in the selling field all his life, H. W. Buschman, H. W. Buschman Co., St. Louis, addressed the meeting on the art of selling. Mr. Buschman said that the idea that price, location or quality are the prime factors in sales is all wrong—the prospects do not have the knowledge to make comparisons. He said that 75 percent of sales are made because of salesmanship—personality is the thing that does it. The best salesmen like people and like to talk. They must think clearly and express themselves well.

He said that in making a sale one must first get the attention and interest of the prospect often by visual means, painting a picture of the black past and the rosy future, covering the sales motives, and emphasizing those that appeal, to the point where the prospect wants the product more than the money it will cost.

Problems of a commercial nature were brought to the attention of the meeting by A. F. Metzger, Allegheny County Steam Heating Co., Pittsburgh, chairman of the commercial relations committee and his committee members.

Present Status of Panel Heating

The present status of the panel heating art was discussed by J. S. Locke, Minneapolis-Honeywell Regulator Co. He said that a genuine rather than a passing interest in panel heating had resulted in its rapid advance in popularity without promotion by the commercial interests involved.

Mr. Locke differentiated between panel and radiant heating, saying the former employed low temperature radiation from the walls, floor, or ceiling, while the latter required a very high temperature source of radiation, such as a portable electric heater. Panel heating, he said, is usually provided by (1) the circulation of warm water in pipe coils, (2) the circulation of warm air in ducts or hollow air spaces, (3) embedded electric cables, or (4) heated tapestries and wall paper on or within the ceiling or the walls. Floor installations usually have been found least expensive to install but overheating due to heat storage has been a problem which would require the application of adequate control, he stated.

He concluded by saying that while there are many hundreds of installations operating satisfactorily in homes, apartments, factories, offices, and institutions, they might have been installed for a smaller investment had there been available design data based on thorough test, research, and theory—such as the American Society of Heating and Ventilating Engineers has begun to make public.

P. A. Hyde told of the satisfactory operation in a furniture store in Akron of a new panel heating system, employing 3000 ft of 1¼ in. wrought iron pipe and having a circulating pump controlled by a room thermostat.

Mr. Hyde also reported on his investigation into the type of information that could be obtained on the characteristics of old and obsolescent radiation sometimes encountered in buildings by district heating engineers. It was agreed that there was not enough need for the data to warrant the work.

What Steam Pressure Is Needed?

Carl B. Sprenger, Detroit Edison Co., presented papers on two interesting subjects. In the first of these he said that, excepting those customers who operated critical processes, the average steam buyer does

not know what the minimum steam pressure is that he needs. Whereas low pressure steam often does the job just as well in a proper installation, high pressures have been maintained. He said that this has been proved in tests at several firms where reductions had been made from 100 psi to as low as 30 psi.

In his second paper, Mr. Sprenger told of a simplification in design of an installation to keep exposed sprinkler system tanks from freezing. An immersion type thermostat, a clock, an outdoor thermostat, and a motor valve are required. Water circulates over the immersion thermostat after steam has been turned on and steam remains on until the thermostat is satisfied. However, steam will not come on if the outdoor temperature is above 32 F. The motor valve, located near the source of the steam, eliminates line loss.

Snow Melting

The greatest difficulties encountered are the expansion of the fluid-carrying tubing when heated and the freezing of condensate in the lines, according to Harry L. Roe, Dayton, in his brief resumé on snow melting.

R. A. Parsons, engineer with the Board of Water and Electric Light Commissioners of Lansing, Mich., reported on water heating with district steam. He said the all-year steam load of water heating is valuable to the heating utilities but it is being lost because improperly sized heaters or the wrong type of heaters are being installed, and because poorly maintained heaters are giving poor service. His recommendations were (1) that copper tubing be used to overcome corrosion and scale formation, (2) that minimum water temperatures be maintained, (3) that high and low temperature water uses be separated, (4) that oversize heaters be installed to give satisfaction without frequent cleaning, (5) that connections be provided to introduce and remove solvents, and (6) that instantaneous heaters in combination with storage tanks be used to keep the steam demand down.

Combined Electric and Steam Service

As a part of the program of the research committee, of which A. R. Mumford, Combustion Engineering Co., is chairman, Ward F. Davidson, Consolidated Edison Co. of New York, reported on American and European viewpoints on the combined operation of electric and steam service. After reviewing the analytical steps necessary to estimate equipment and fuel savings to be gained by a combined operation, Mr. Davidson described operations in New York, Rotterdam, Paris, and Denmark, of which analyses recently had been made.

His general conclusion was that the best balance is reached when the base steam load of the district heating system is supplied by a combined steam-electric station and peak loads are taken care of by boiler plants located as near as practicable to the principal load centers.

A report was given on the investigation made by Charles F. Donohoe, G. H. Tuttle and Glen D. Winans (all of Detroit) on the feasibility of converting a district heating system using steam as the heat-carrying medium to one using high temperature water for this purpose. Their conclusion was that it is entirely out of the question to convert because of the work and cost involved and the space required on the customer's premises. They did, however, agree that serious consideration should be given to high temperature water where it can be used directly.

Paul L. Geiringer, chief engineer of the American Hydrotherm Corp., and others, discussed the advantages of high temperature water. Mr. Geiringer said (1) it permits more economical distribution of heat, (2) it permits greater power production, and (3) it greatly reduces operation, repair and maintenance expenses.

Large Increase in Generating Capacity

Nineteen utilities of a total of 52 supplying information to the steam station engineering committee reported to Chairman R. B. Donworth that they are adding 36 boilers having a total capacity of 5 million lb per hr to their systems. These installations will increase the total capacity of these particular companies by about 25 percent and will increase the total capacity of NDHA members approximately 15 percent. Mr. Donworth said that 10 boilers have spreader stokers, seven have traveling grates, six have underfeed stokers, six are equipped to burn powdered fuel, five to burn oil, and two to burn either oil or powdered fuel.

In addition to the basic factor of outside temperature, Thomas P. Brown, Jr., assistant to manager of the production department of the New York Steam Corp., reported that their latest survey of the problem revealed there are five other factors that must be considered in computing peak sendout. They are (1) the day of the week, (2) mean temperature of the preceding day, (3) average wind velocity, (4) average humidity, and (5) the served cube.

AIR CONDITIONING INCREASES BUSINESS

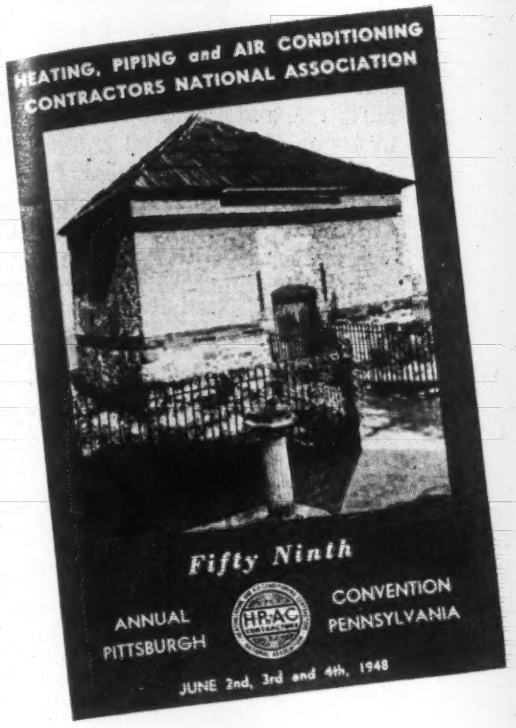
Independent surveys showing increases in business volume of from 20 to above 35 percent on a year 'round basis as a direct result of air conditioning in stores, restaurants, and hotels were reported by Carrier Corp. representatives at the Second International Store Modernization Show in New York last month.

The surveys on increases in business volume in air conditioned establishments were conducted by trade publications on either a nationwide or spot basis. One study was confined to beauty shops in the state of Ohio. The poll showed that 17 percent of those questioned were using air conditioning, with an additional 7 percent in process of installing such equipment.

The air conditioned shops reported "an average increase in yearly dollar volume, following installation, of 36 percent." Approximately 95 percent of the conditioned shops showed an increase in "new customers."

Individual drug stores reporting from Detroit, Lincoln, Neb., Davenport, Ia., and Ashville, N.C., showed sales increases ranging from 20 percent to well above 30 percent, with sales in some individual lines increasing by as much as 50 percent. The latter figure applied to summer toiletries in Lincoln, and to lunch business in a chain in Davenport.

Publishers in the hotel and restaurant field reported that 98 percent of the individuals questioned considered air conditioning a "good investment," and found patronage increases ranging to above 35 percent.



REVISIONS to various engineering standards, such as net load recommendations for heating boilers and air conditioning standards, together with discussions of apprentice training and labor relations, given at the 59th annual convention of the HPACCNA, are summarized in a report concluded from July

Contractors Hear Reports on Labor Relations, Technical Data Revisions

Activities and accomplishments of the Heating, Piping, and Air Conditioning Contractors National Association were brought to the attention of members attending the recent 59th annual convention of the association by means of numerous committee reports. Presented by the respective committee chairmen, these reports not only outlined work accomplished, but indicated studies which are planned for the coming year.

In reporting on the activities of the boiler output committee, Harry M. Hart, president, L. H. Prentice Co., Chicago, said that the rule for computing the boiler size for heating water for domestic use had been revised to conform to the standards of the Institute of Boiler and Radiator Manufacturers, that copies of the committee's net load recommendations for heating boilers are now being furnished to 82 officials in charge of smoke prevention work in various municipalities throughout the country, and that part 2 of the association's engineering standards have been revised to comply with the current boiler output standards. He also indicated that net load recommendations for steel boilers not constructed in accordance with the code of the American Society of Mechanical Engineers will not be published in the association's booklet on net load recommendations for heating boilers.

Load Same Whether Boiler Is High or Low Pressure

In answer to a recommendation made at the annual meeting last year in regard to ratings for high pressure boilers, Mr. Hart said that his committee had endeavored to secure the cooperation of the ASME and had been advised that standardization of boilers is not a function of the ASME boiler code committee which is concerned primarily with the formation of safety rules. He reported that the SBI standards now in use should apply, and he stressed the fact that most high pressure boilers are designed for power use and are often tailor made for particular installations. When a boiler is operated at high pressures for heating structures, the load is no different than if the boiler were operated at low pressures, he said.

In answer to a recommendation, made at last year's annual meeting, that the committee attempt to establish ratings for low pressure boilers (both cast iron and steel) not now included in the association's net load recommendations, Mr. Hart mentioned that his committee has always attempted to do this but that cooperation of the manufacturer is necessary as a nominal charge is made to the man-

ufacturer to help defray the cost of printing and distribution of the booklet and the manufacturer must endorse the recommendations. There are several makes of boilers which the committee would like to include, but to date manufacturers' endorsements of the net load recommendations have not been received. It was pointed out that net loads for cast iron boilers not listed in the association's booklets can be determined from part 2 of its engineering standards. Standards for steel boilers may be calculated from the SBI standards.

Boiler Size Recommendations for Panel Heating Deferred

A year ago it was recommended that the committee investigate present boiler ratings to determine whether smaller boilers can be used for radiant panel heating installations. After conferring with the I-B-R engineering committee, it was decided to defer this matter until more information on this type of heating is available. In Mr. Hart's opinion, it is quite probable that radiant panel systems are being installed with more radiation than is necessary and that boilers would be more correctly sized if their selection were based on the calculated heat loss of the building rather than on the amount of installed radiation. This, he said, applies to any type of hot water heating system.

Mr. Hart cited the great improvements, made during the past decade, in the efficiencies of cast iron boilers and said that the manufacturers are to be congratulated on improved appearance.

In regard to the standards for testing and rating hand fired hot water supply boilers, adopted by the U.S. Department of Commerce and accepted by the industry as a recorded standard of the trade (see page 210, July HPAC for discussion of the standard), he said that the standards were not adopted without considerable controversy but he is confident they will prove of great value to the industry.

Again this year, he said, no boiler output failures were reported when boilers were properly selected from the net load recommendations.

At the conclusion of this report, John H. Zink, Heat & Power Corp., Baltimore, acting on behalf of the entire membership, presented a certificate of appreciation to Mr. Hart for his untiring efforts, over many years, for the association and its committees. He particularly mentioned his fine work on boiler standardization. In expressing his appreciation, Mr. Hart said that he has derived far more benefit from his association work than he has given.

Engineering Standards Being Revised

The report of the engineering standards committee, given by Chairman Paul A. Edwards, G. F. Higgins Co., Pittsburgh, indicated that much publicity and favorable comment are being accorded the association's standards. He mentioned the new fifth edition of part 2 of the standard, Net Square Feet Radiation Loads Recommended for Low Pressure Heating Boilers, prepared by the boiler output committee, and invited comments and suggestions from members. The problem of checking and reprinting parts 1, 3, and 4 of the standards is, in his opinion, essential and should be completed in the near future. Part 5 cannot be revised until the American Standards Association committee, now working on symbols, has finished its work. In connection with the project of standardizing stainless steel tube and fittings, the association standards have been accepted by the ASA for approval.

According to Mr. Edwards, suitable standards on radiant panel heating will be prepared when sufficient data are available.

As the association's representative on the standards council of the American Standards Association, Rowland Tompkins of Rowland Tompkins & Son., Inc. of New York City, reported that he had cast an affirmative ballot for a change in the ASA constitution for the addition of an article authorizing the incorporation of the ASA by obtaining a Federal charter and also, if in the opinion of the board of directors it seems desirable, a state charter as an interim measure. He then referred to eight ASA standards which are of interest to members and which have been approved during the last year. These are shown in the accompanying listing.

ASA Standards Approved During the Last Year Which Apply to Boilers and Pipe

Forged or Rolled Steel Pipe Flanges for General Service (ASTM A 181-46; ASA G46.1-1947).

Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings and Valves and Parts for High Temperature Service (ASTM A 182-46; ASA G37.1-1947).

Carbon-Silicon Steel Plates of Ordinary Tensile Ranges for Fusion-Welded Boilers and Other Pressure Vessels (ASTM A 201-46; ASA G31.1-1947).

Chrome-Manganese-Silicon (CMS) Alloy Steel Plates for Boilers and Other Pressure Vessels (ASTM A 202-46; ASA G32.1-1947).

Molybdenum-Steel Plates for Boilers and Other Pressure Vessels (ASTM A 204-46; ASA G34.1-1947).

High Tensile Strength Carbon-Silicon Steel Plates for Boilers and Other Pressure Vessels (Plates 4½ in. and Under in Thickness) (ASTM A 212-46; ASA G35.1-1947).

Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service (ASTM A 194-46; ASA G38.1-1948).

Copper Water Tube (ASTM B 88-47; ASA H23.1-1947).

Panel Heating in Great Demand

In his report of the home heating committee, J. A. Ljunggren, General Heating Corp., Chicago, said that panel heating, both floor and ceiling types, has been in great demand, but pipe shortages have retarded progress. He also reported that the use of a continuous circuit around small apartments in multiple buildings is meeting with great favor and is being used extensively in the Chicago area. This, he said, is true even where a central heating boiler is used. In most installations, individual thermostats in each apartment operate motorized valves so as to provide independent temperature control.

After calling attention to the great popularity of baseboard radiation, Mr. Ljunggren said that certain practical features in the design of some units have been neglected.

For example, where baseboard radiation has been designed for installation on finished plastered walls, the problem of providing temporary heat to make it possible to plaster the rooms during winter construction will discourage its use. He also said that smudging of walls has, in some cases, become a major problem*. In fact, he thinks that the future success of some types of baseboard radiation hinges on the elimination of smudging wall surfaces. He cited his personal experience on 146 jobs placed in operation during the past heating season where smudging was a complaint. He called these facts to the attention of the manufacturers and more recently has worked with them in developing a new covering plate which was tested over a period of four months. He reported that it will make possible a guarantee against visible smudging over a reasonable period.

Air Conditioning Standards Revised

W. S. Bodinus, Carrier Contracting Corp., Chicago, as chairman of the committee on air conditioning, reported that the engineering standard on comfort air conditioning has been completely reviewed and reorganized. Some of the highlights of this new issue of part 4 of the association's engineering standards include the use of new psychrometric data which cover the change in total heat values using enthalpy instead of the sigma function.

A compend of several technical publications including that of the Air Conditioning & Refrigerating Machinery Association is also included. The technical data added are of a more comprehensive type and corrections of some values have been made because of developments which have taken place since the previous issue was published seven years ago. The revised standard is now being set in type.

Recommends Textbooks for Apprentice Training

Last January, a questionnaire on apprentice training was sent to the secretary of each local association. The information obtained from this survey, which covered 27 cities having apprenticeship systems in 18 states, provided useful data which were discussed by Arnold H. Goelz, Kroeschell Engineering Co., Chicago, and chairman of the committee on apprenticeship.

The local associations replying to the questionnaire had 2250 apprentices indentured, with ratios varying from one apprentice to one journeyman down to one apprentice to 23 journeymen. Maximums as low as three apprentices to a shop were reported. Eight reports showed a ratio of one to five, and methods of indenture varied. Seventeen local associations indicated indenture to a joint committee, four to unions, and the rest to contractors. The minimum of 144 hr per year of instruction in related subjects is well accepted, though one city reported less than that number of hours and one city reported over 300 hr.

According to the replies, 20 cities use the association's standard textbooks while seven do not. Mr. Goelz stated that his committee believes that every city which is not using the books should adopt them as a means of improving the instruction in related training.

As to joint committees and financing, 26 cities reported operating with joint committees varying in size from four to 16 members. Only three cities reported operating with an annual budget. Seven cities indicated that expenses are borne by the public school system or the Veterans Administration. One city said that all funds are furnished by the union, and in two cities the contractors' association finances the program. In the remainder of the 27 cities, expenses are shared by the association and the union acting through joint committees.

Mr. Goelz also stated that a subcommittee is now preparing an outline of the curriculum on related training covering the five year period. This outline will list in detail the subjects included, with the time allotted for each and references by page number to related subject matter in the manual.

Apprentice Training a Local Activity

M. M. Hanson, of the apprentice training service, U. S. Department of Labor, was asked to address the members. He said that with over 270 field men in 200 cities, the department is now set up on a local basis. Apprentice training, he said, is the sole responsibility of local associations and unions. With 125,000 apprentices being trained in the construction industry under the jurisdiction of local committees, the program is rolling along. However, in his opinion, the goal is 5000 local committees as there must be 200,000 apprentices in training at all times. He also stated that there are now 515 joint committees in the plumbing and steamfitting trades and he made the following suggestions for local committees: (1) keep a simple record system for each apprentice, (2) indenture the apprentice to the committee, (3) publicize the com-

Pittsburgh's "Golden Triangle" where HPACCNA members recently gathered for their 59th annual convention

*Speaking of tests with radiant baseboards at the University of Illinois, Prof. Warren S. Harris said that this type of system is outstanding in cleanliness with water temperature not over 200 F (see HPAC's report of the 1947 Midwest Power Conference, page 95, June 1947 issue)—Ed.

mittee's work—use a graduation ceremony, for example, (4) place the association's standards in operation and check on the progress of the apprentice, and (5) inasmuch as someone will have to do a great deal of work, see that either a full or part time man is engaged to carry out the work of the committee.

Predicts Decline in Income Construction

Because of new price advances, wage increases, government spending, etc., the predicted business recession for the Spring of 1948 did not materialize, though there were many indications that it was "just around the corner." These remarks prefaced the report of the committee on trade promotion, given by Chairman George P. Nachman, of the Spohn Heating and Ventilating Co., Cleveland. Stating that no one can foresee how rapidly the defense program will get under way and that world conditions can change overnight, Mr. Nachman said that the decline in new projects for income purposes is already affecting a number of architects and engineers. He predicted a further decline which which will be felt by contractors. However, he pointed out that industrial construction for the new defense program will probably keep the grand total at the same or even a higher level.

Referring again to the decline in projects for income purposes, he cited the general tightening of credit and the higher interest rates being asked, and he reminded the members that now is the time to keep their houses in order, their assets liquid, their tools and equipment in the best of condition, sales and engineering personnel wide awake, and management alert and aggressive.

Survey Shows Increased Overhead Expenses

In response to the association's overhead survey questionnaire, 218 replies were received this year as against 221 replies last year. Though the number of replies represents a small percentage of the total membership, Mr. Nachman believes that 80 percent of the replies are received each year from virtually the same firms so that comparisons may be made. Based on the 218 unsigned reports, the average 1947 turnover (defined as the yearly gross dollar volume of business divided by the net worth of the firm) was 5.5 as against 4.49 in 1946. It is reasonable to assume, said Mr. Nachman, that both the volume and net worth have increased during the last few years.

Again based on 218 replies, the average overhead costs of the reporting firms amounted to 17.98 percent of total costs during the year 1947. This compares with 18.4, 17.62, and 16.12 percent for the years 1946, 1945, and 1944 respectively. The unweighted average for the last decade of these annual overhead surveys is 17.08 percent. In other words, the overhead expenses have kept pace with the volume of business. The average 1947 net profit of the reporting firms was 5.25 percent after taxes.

The gross volume of business, as reported by the 218 firms, varied from $35,000 to $5 million. Projecting the reports across the entire membership, Mr. Nachman stated that the total volume of business done by members of the association is between $\frac{1}{2}$ billion and $\frac{3}{4}$ billion.

Form of Interim Labor Contract Prepared

Labor relations under the Taft-Hartley act was the subject of a talk by John C. Hayes, of Hayes and Hayes, Washington, D. C., counsel for the association. He discussed various provisions of the act as they affect the members. These included the closed shop and union shop provisions, the union security clause, the cost of elections, jurisdictional disputes, secondary boycotts, and check-off provisions.

According to Mr. Hayes, it was found that in a number of instances where labor contracts had expired, members were about to sign new contracts which violated portions of the Taft-Hartley act. Believing that some of the terms of the act will be revised and that contractors need more time in which to become familiar with the various provisions, an interim form of labor contract has been prepared. This has been approved by the United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industries of the United States and Canada and was presented to the members of the association by Mr. Hayes with the statement that it can be used (legally within the Taft-Hartley act) as the basis for individual agreements between contractors and local unions—subject to state and federal laws and subject to local agreements on qualification requirements of journeymen and apprentices. Mr. Hayes recommended adoption of this form by the national association.

In regard to industry jurisdictional disputes, the speaker pointed out that the National Labor Relations Board has, in effect, delegated its power to a national joint board for settling these disputes in the construction industry. While this is a voluntary board, it is far more familiar with the problems of the industry than is the NLRB. Inasmuch as the voluntary board can only render an opinion, disputes can be carried to the NLRB which, of course, has the power to reverse a previous opinion. According to Mr. Hayes, this is rather unlikely.

When asked to address the members, Martin P. Durkin, president of the United Association, said that the Taft-Hartley act has "created a great deal of confusion and has interfered with the old, time tested labor-industry method of settling disputes." He, too, commented on the voluntary method of settling jurisdictional disputes stating that the NLRB refuses to handle petitions in this industry.

Members Enjoy Inspection Trip

Other features of this 59th annual convention included a trip through the McKeesport, Pa., plant of the National Tube Co. (where members viewed the production of seamless steel pipe) and an address on Selling the Public by Cecil W. Farrar, director of sales promotion, Richmond Radiator Co.

"Don't sell pipe or ventilation—sell comfort," urged Mr. Farrar. "It is the product of your craftsmanship and art . . . . . a part of the construction business which this year will total $11 billion to $12 billion." Inasmuch as the rendering of comfort is a "personalized" business, he suggested that members devote a good deal of time to customers and prospective customers who are the real bosses of a contractor's business.

QUESTION OF THE MONTH

YOU ARE invited to submit a heating, piping, or air conditioning question for publication here. You are also invited to submit answers to previously-published questions from others. Those published are paid for at regular rates. Address the Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Ill.

How Improve Conditions in Top Story Drafting Room?

In the June HPAC, "C.H.S." asked for suggestions on keeping an 80 by 80 ft drafting room on the top floor of a building more comfortable. He mentioned particularly the sun heat gain through the black roof, and asked about evaporative coolers. The equipment should not become a part of the building, he specified, as the space is leased

IN THE JUNE issue, "C.H.S." posed the Question of the Month about how to make his top story drafting room comfortable, and asked about evaporative coolers in particular. Since the editor did not do a very thorough job of filling out a survey sheet for this "job," neglecting to state in what section of the country the problem lies, we lack data on design conditions especially useful when evaporative cooling is to be considered.

Making a few assumptions on lighting load and building construction, a rough heat gain on the office runs about as follows:

Sensible	294,500
Latent	13,500
Outside Air	
Latent	8,000
Sensible	16,200
Total	332,200

Reduce the Roof Load

Regardless of the type of air conditioning installed, and whether or not any form of air conditioning is installed, the roof load should be reduced by one of the two following methods:

1) The roof could be painted with asphalt aluminum paint, which costs approximately $5 per gal, with coverage of about 300 or 400 sq ft per gal being obtained. Overall cost should run about $200 for the job. The reflective coating will reduce the roof load by about two-thirds, making it 50,000 instead of over 150,000 Btu per hr. If "C.H.S." is a good salesman, he may be able to sell the building owner on doing the job as a means for increasing the life of his roof by greatly reducing expansion cracking.

2) If water is available in adequate supply at reasonable rates, the roof can be sprinkled. A good job would reduce the cooling load 75 percent. Thirty to 40 gpm would be required. Cost would run somewhat more than the paint job. If self-contained air conditioners were installed, the cooling water could be wasted through the roof sprinklers.

Regarding radiant heat from the ceiling, I believe "C.H.S." can neglect its consideration because roof sun factors allow for the total heat through the roof whether or not it ends as radiated or convected heat. In addition, the reflective roof will end his radiation worries.

Refrigerated Air Conditioning

Considering first a refrigerated air conditioning job with self-contained units, the net cooling load would be around 20 tons, and four 5 ton units are suggested.

Two units could be installed against opposite walls as shown in the accompanying sketch, blowing parallel to ceiling beams, if any.

QUESTION OF THE MONTH

Advantages for this type installation are:

1) Year around comfort would be provided — cooling, dehumidifying, and moderate air circulation. Winter use could be included.

2) Drafting room could be kept clean at all times—especially valuable in business and industrial areas all year.

3) Excellent salvage value.

The job would cost approximately $7000, assuming power and water are readily available.

Evaporative Cooling

If "C.H.S." is in a section of the country where the design wet bulb does not exceed 65 F, he can get very good results for summer *only* operation using a careful installation of evaporative coolers. If the design wet bulb runs up to around 70 F he can get only fairly satisfactory results.

By "careful installation" I specifically mean:

1) Use of quality units.

2) Good distribution of air in the room, using four units on the roof; and with aspirating type diffusers near the ceiling, one for each unit. Location of units and diffusers should be with due attention to ceiling beams to help avoid drafts.

Air quantity required for a 65 F design wet bulb area would be about 20,000 cfm; or 30,000 cfm in a 70 F area.

For the lower figure, four 7500 cfm units are recommended; or four 10,000 cfm units for the larger air quantity. It pays to play a little safe on unit rating, as most evaporative coolers operate very much better at somewhat below their peak rated capacity, in my experience.

Advantages of the evaporative cooler installation are:

1) Low first cost.

2) Low operating cost.

3) Least water quantity required.

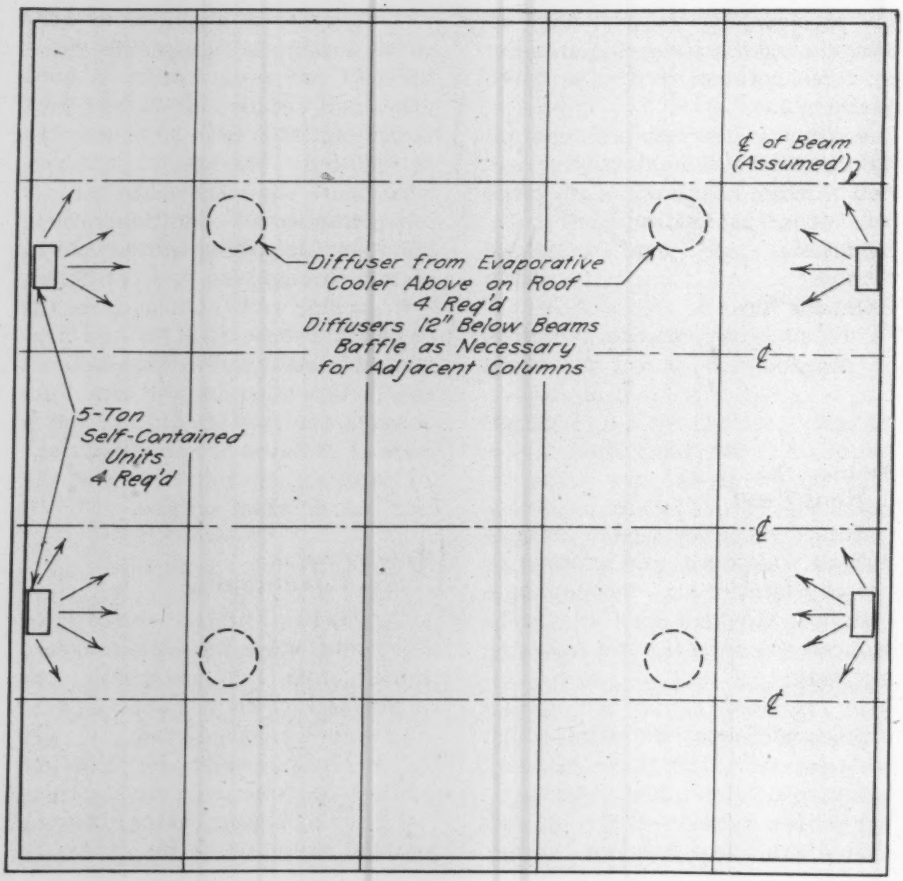
Disadvantages are:

1) Not suitable for winter and between-season operation.

2) Air movement may be excessive in some occupied areas, even with the best air diffusers.

3) In a 70 F wet bulb zone, there will be some summer days when humidity will be too high for comfort.

"R.M.S." suggests this arrangement for self-contained units or evaporative coolers


℄ of Beam (Assumed)
Diffuser from Evaporative Cooler Above on Roof 4 Req'd
Diffusers 12" Below Beams
Baffle as Necessary for Adjacent Columns
5-Ton Self-Contained Units 4 Req'd

4) The equipment is of rather light construction, and its life should be considered at perhaps no more than half that of self-contained air conditioners.

The job would cost approximately $3000, of which $2000 would be the cost of the units themselves.

Fans would be manually controlled: A room thermostat for each unit would control the spray pump and slinger motors. As a more refined control, a high limit humidistat may be included in series with the thermostats to cut out the water when excessive humidity is reached. This device is especially desirable in the higher wet bulb areas.

Suitable protection switches should be provided for all motors.

"C.H.S." is urged to be wary of rule-of-thumb artists who may offer an inadequate system.—R.M.S.

SHOULD PAINT ROOF, INSTALL SKYLIGHTS

Answering the question of "C.H.S." in the June issue, it is understood that the 80 x 80 ft roof is over a drafting room; that there are no skylights in the ceiling; that the space is rented; that there shall be no fixed equipment forming a part of the building; and that insulation of the roof is not to be considered.

The first thing to do is to reduce the absorption of heat by the black roof. I would first spray that black roof with a heavy white and glossy paint, or an aluminum paint.

The next step would be to create a slow movement of air through the room; strong enough for the draftsmen to feel the evaporative effect on their exposed skin; on the wrists, for instance.

The air movement should also sweep the ceiling. For equipment, a portable motor-driven fan, with canvas ducts attached to the outlet to direct the streams of air, could be used.

If the landlord would put in a few box skylights, a fan might not be needed. The skylights would reduce the amount of artificial lighting during the day, and the heat therefrom. The skylights should be adapted to open, a cover being hinged on the south side of the box; or on the west side, if the prevailing breezes are from that quarter. There would then be a current of

air from the windows to the skylights.

The cover or top of the skylight should extend beyond the walls of the box, and the edges should be provided with a skirt about 2 in. in depth to drain rain water away from the under side of the cover lest it be blown into the inside of the box.

The cover is a simple glazed frame. The glazing may be double to reduce heat transmission. The skylight should be painted white on the outside. This covering frame and the box of the skylight should be of wood. With metal there would be the danger of condensation, and of drip upon the drawing boards below.—A.S.

MANY ANSWERS TO THE PROBLEM

THE QUESTION of the Month from "C.H.S." in the June HPAC regarding the method to use to keep a top story drafting room comfortable is one having almost as many answers as the leaser of the space has dollars to spend.

I would like to begin an analysis of the problem by disposing first of the last portion of the question—the feasibility of evaporative cooling. The only way evaporative cooling could be made effective would be to take large quantities of outside air through an air washer where it would be saturated at the outside wet bulb temperature (75 to 80 deg maximum, depending on the locality). This saturated air would then pick up the cooling load in the space (93 percent sensible in the case under consideration) before being exhausted.

If any appreciable cooling effect is to be gained by such a system, the amount of air handled would have to be excessively large and even then the cooling accomplished would be done by building up a high relative humidity—obviously undesirable from a purely comfort standpoint. Furthermore, the equipment required—which consists basically of a centrifugal fan, air washer, spray pump, air mixing chambers, piping, controls and ducts—would be, once installed, of a permanent nature. This would be highly undesirable when the space under consideration is being leased. Therefore, I would eliminate evaporative cooling from the picture and tackle the problem along the lines described below.

Natural Application for Roof Sprays

From the brief description of the drafting room as given, it seems to be a natural application for a roof spray installation. Calculations show that some 8½ tons of heat come through the roof on a sunny day and it would be possible to eliminate this heat entirely by a properly designed roof spray system. The cost of such a system installed estimates to be approximately $1000, which is equivalent to getting air conditioning refrigeration at something like $118 per ton—any air conditioning estimator will agree that this is a real bargain in these times. Furthermore, the operating cost of the sprays would be extremely low. For instance, figuring 0.08 gal per hr per sq ft on the roof (which is 100 percent more than theoretical requirements) the total water for the 6400 sq ft would be 512 gal per hr.

Exactly how much of a reduction in the drafting room temperature would be accomplished by the sprays is dependent on a number of factors, such as the outside wet bulb temperature in relation to the dry bulb, number of windows open, direction and velocity of prevailing wind, and amount of other internal cooling loads, such as lights, people, etc. Based on the results noted with the limited number of roof spray systems installed to date, the drafting room will probably be from 10 to 20 deg cooler with a good roof spray system than without.

WANTS DATA ON SKATING RINK CONDITIONS

You are invited to comment on the following question from a reader. Suitable comment on this matter will be published, and paid for at regular rates (with additional payment for sketches). Address The Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2.

"We have been endeavoring to find data relative to room temperatures that exist in a room containing an ice skating rink. Any information along these lines will be appreciated."

QUESTION OF THE MONTH

If it is desired to go further in making the area comfortable during the hot season, propeller fans could be installed in the windows or walls to give about a 3 min air change. The installed cost of three fans sized on this basis would be about $850, which—added to the $1000 for the roof spray system—gives a total cost of $1850. This combination, while giving no mechanical refrigeration and dehumidification, would eliminate and remove the major cooling loads such as roof sun, window sun, people and lights. They would not be allowed to build up any temperatures in the space, and the air motion created by the propeller fans would further advance air conditions toward an acceptably comfortable state.

Providing Air Conditioning

To provide full-fledged air conditioning—i.e., maintain conditions at something like 80 F dry bulb and 50 percent relative humidity—would, of course, require mechanical refrigeration plus a duct system to distribute the conditioned air. The cooling load of the space figures to be about 28 tons based on this inside temperature and relative humidity and outside conditions at 95 deg DB and 78 deg WB. A single unit conditioner sized to meet this load would cost installed approximately $6000 including ductwork, piping, wiring, controls, engineering, etc. If a roof spray system were installed to knock off 8½ tons of the cooling load, the initial cost of the combined installation would also be about $6000 but approximately $2.50 per day could be saved in operating cost.

In closing, it might be mentioned that all the foregoing estimates are based on a lighting load of 2 watts per sq ft, which is about average for a drafting room. This amounts to a total cooling load of 3.6 tons, which is 13 percent of the total without roof sprays and 18 percent with roof sprays. Therefore, if it is possible to keep the lights off in the room during the bright, sunny portions of the day, a considerable saving in air conditioning should be accomplished both in first cost and in operating expense.—F.C.J.

HOT CEILING RADIATES TO OCCUPANTS' HEADS

In reply to "C.H.S.'s" question on how to keep a top floor comfortable, two points are outstanding in the description of the situation—the entire wall area amounts to only 3840 sq ft, while the ceiling measures 6400 sq ft (all of which is sun-exposed all day long); the other is that no substantial expenditure is allowed for non-salvageable equipment such as insulation of the ceiling, structural supports for a cooling tower, etc.

As with every problem, this one should be analyzed first as to the cause of the condition to be improved or relieved. Obviously the room is not uncomfortable from crowding, with 74 persons on 6400 sq ft. But the occupants have a vast expanse of hot ceiling surface radiating onto their heads with a force of at least 30 F temperature differential, because the summer sun will raise the roof temperature to more than 140 F. Unless this influence is nullified, there can be no thermal comfort. No matter how cool and/or dry the air is made by refrigeration, there will always be that radiation from the ceiling on the head, and it will be more noticeable if the room is air cooled.

Bring Roof Temperature Down

Air cooling, as considered by "C.H.S.," can only help if cold air is blown at the ceiling and at a rate sufficient for absorbing about 300 Btu per sq ft per hr x 6400 sq ft, or 1,920,000 Btu per hr. One might as well insulate the ceiling and forget the cost of it were it not for roof cooling. At a cost of between $200 and $250 (depending on the location of the water supply) and of which at least one-half is readily salvageable, the roof temperature can be brought down to below the dry bulb in the shade and the ceiling temperature to below the occupants' body temperature.

Evaporative coolers may further improve the situation, essentially by their ventilating effect. They should be sized to take care of about 74 x 400 or 29,600 Btu per hr without raising the relative humidity above 50 percent. Their cost, however, must of course be considered in relation to the cost of roof cooling.—S.R.

Stoker Makers See Increased Sales

The 31st annual meeting of the Stoker Manufacturers Association, held recently in Chicago and attended by 125 top stoker executives and representatives of the coal and other allied industries, "struck a high note in practical ideas and plans for cooperative and harmonious relationships between the stoker and allied industries." The meeting was highlighted by talks of bituminous and anthracite coal industry spokesmen "which will provide impetus to a much closer working relationship between the producers of coal and manufacturers of automatic burning equipment," SMA officials said.

George W. Graham, retiring SMA president, said that the stoker industry expects a substantial increase in the sale of equipment this year compared with 1947, and that the stoker trade in general is encouraged over the long term prospects for increased sales volume although it is "just simply a question of how much effort, time, talent, brains, and aggressiveness we as stoker manufacturers can devote to the sale of more equipment provided all other things are equal and we are not stymied because of conditions beyond our control. . . ."

H. A. Glover, Huntington, W. Va., vice president in charge of sales, Island Creek Coal Sales Co.—who spoke as a representative of the sales executive group in the bituminous coal industry—told the convention that a survey recently made by his group indicates an adequate and ever-increasing supply of prepared and treated domestic and commercial stoker coals from the major producing coal regions of West Virginia, Kentucky, Tennessee, and Illinois, for the coming heating season, unless strikes and car shortages interfere with production and distribution operations. Mr. Glover urged stoker manufacturers to make every effort to develop stoker equipment capable of utilizing a wider range of bituminous coals. If this can be done, he said, it will make available "a prolific source of additional well-prepared and high quality coals for stoker use both in commercial and domestic applications."

E. H. Walker, New York City, vice president in charge of public relations of the Anthracite Institute, outlined the advertising and merchandising program on anthracite for the summer and fall months. He stated the producers of anthracite are solidly behind the sale of anthracite stokers and that for the forseeable future there will be plentiful supplies of anthracite stoker coal sizes. J. Nelson Stuart, manager of the coal heating service division of the National Coal Association, described the operation of the various coal heating service groups in some 34 cities which cover a market embracing a population of 12,000,000 people. In commenting on the stoker industry's interest in coal heating service, Mr. Stuart remarked that "stoker sales will gain in direct proportion to the extent to which stoker manufacturers, distributors, and dealers adopt proved plans and programs in the different communities where groups are operating, and that the larger the coal heating service market the larger and better the market will be for stokers. . . ."

The following officers were elected by the SMA for the ensuing year: President, Claude A. Potts, vice president, U. S. Machine Corp.; vice president, Howard E. Sill, vice president, Muncie Gear Works, Inc.; secretary-treasurer, C. P. Meredith, vice president, Steel Products Engineering Co.

"Open for Discussion"

DO YOU HAVE something to say about any of the articles published this month? An additional comment, or perhaps a question on some point? We follow here the custom of engineering society meetings in allowing a period for discussion following presentation of a paper. You are invited to contribute your views. Address the Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago

J. R. Kell Replies to Comments on High Pressure Hot Water Heating

I HAVE READ with interest the remarks on my articles on high pressure hot water heating published in the "Open for Discussion" columns of the May and July issues of HPAC.

Dealing first with Paul L. Geiringer's comments in the May number, I did not state that the temperature limit was 350 F. I merely said that the systems commonly worked at 300-350 F. I agree with Mr. Geiringer that there is little to be gained by raising the pressure unduly; indeed, the additional cost of the heavier piping, flanges, valves and other pressure parts of the system, would outweigh the slight savings which could be effected by using bigger temperature drops.

My remarks on the subject of adding new circuits to an existing HPHW system which was not designed to take them, were intended to indicate that there was a point here that must be watched. With a steam system it is frequently possible to add new connections to an existing piping system, and still maintain an adequate supply of steam with a slightly greater pressure drop, but with water circulation, the addition of a new circuit might upset the balance of the rest of the system.

Dealing now with C. M. Humphreys' comments in the July issue, the addition of percentages to transmission from heating surface for comfort effect was quoted from a manufacturer's data sheet. It is only a rough and ready way of allowing for radiant effect. The calculation of mean radiant temperature room by room is a tedious occupation, though it is obviously the only correct method by which to design such a system.

Mr. Geiringer has added some further remarks in the July issue which call for comment:

I cannot agree that the English development of HPHW heating has not yet attained a high degree of efficiency. In a series of articles as presented in HPAC, it is not possible to go into all the fine points in the design of a system, and it is regretted if the impression is left that the treatment is too elementary. As, however, this system is not so common as others, it was thought best to keep to the main principles. Mention is made by Mr. Geiringer of the use of quick circulation boilers, and such have been used on a large scale in this country. In a later article he will find reference made to installations of this type.

He returns to the question of working pressure again, and points out that if the area covered is large, the pressure should be raised to 150, 200, or even 250 psi. From my previous remarks it will be apparent that in the articles, I had already given 350 F as a common working temperature equivalent to about 120 psi. It should be noted here that by going to 200 psi, Mr. Geiringer only raises the temperature of flow from 350 to 388 F, so that if he keeps the return temperature the same he only adds half this difference to the mean temperature of his heating surfaces in the system, i.e., 19 F. Whether this is worth the added cost of heavier flanges, valves, etc., is, to my mind, open to question.

Viscosity of Water

Coming now to the viscosity of water, I could not, of course, have been expected to include reference to the paper by Hawkins and his colleagues published in the ASME Transactions, January 1948. I have, however, now looked this paper up, and would agree that the figures

"OPEN FOR DISCUSSION"

of viscosity calculated by Mr. Geiringer and given in his graph on page 102 of the July HPAC are probably better than any previous information we have had.

The viscosity data given with my table of the properties of water at high temperature was based on the International Critical Tables. I have drawn a curve of these values, and it is apparent that while at 212 F much the same result is given from both sources, as the temperature increases the values quoted by me are lower than those from the other data. This would have the effect of making the differences of pressure drops greater in my case than in those of Mr. Geiringer; but in any event, I am pleased to see that he agrees with me when I stated that extreme accuracy in selecting proper pipe sizes should not be over emphasized.

Coming now to his remarks on radiant heating, vertical plate panels do not allow of dust accumulation. They can be installed in existing factories in a manner which is not possible with a floor heating system. It is interesting to note that Mr. Geiringer's company is developing a system for using high temperature water in low temperature panel heating systems. Systems have been developed in this country for the same purpose; indeed, one has been in use for many years quite successfully.

Is There a Corrosion Problem?

W. J. Ryan, technical manager, Water Service Laboratories, Inc., New York City, has written as follows:

"In the article on high pressure hot water heating systems in the April HPAC, the author states that there is no corrosion problem with such systems 'since the same water is circulated 'round and 'round, and once it has it has exhausted the potency of its initial corrosive agents, if any, it ceases to have any chemical action'.

"However, the author also says that with such a system 'the only make-up required is that due to leakage and blowing of safety valves, etc.'

"As a matter of fact, is it not true that such a system may have a considerable loss of water due to leakage around the packing glands of the circulating pumps? The writer has had occasion to investigate the operation of several low pressure hot water heating systems and has found the loss at the circulating pump to run as high as a pint per minute, which is equivalent to 180 gal of water per day, or 5400 gal per month. At that rate, the turnover of water is considerable and the amount of make-up water that must be fed carries in relatively large amounts of 'corrosive agents'."

I entirely agree with these remarks, but they only point to the great desirability to watch this leakage most carefully, and to take steps by proper maintenance to prevent it. There is no reason why the gland of a pump should allow more than a few drops per minute to get through.—J. R. Kell, partner, Oscar Faber and Partners, consulting engineers, London.

BE CAREFUL WHEN USING CARBON TET

On page 96 of the July HPAC, "F.B.M." suggests the use of carbon tetrachloride for cleaning ventilating ducts and equipment. While I agree heartily that this solvent is a most effective one and I admit that it can be used safely for work of this nature, I fear that the failure of "F.B.M." to stress the danger associated with its use and the necessary minimum safeguards is a serious mistake.

Even in this enlightened age, accidental poisoning and even death from exposure to high concentrations of carbon tetrachloride is not uncommon. There are many people who have no conception of the extreme toxicity of carbon tetrachloride; in fact, its name is so common that many people who should know better are shocked to hear that it is toxic at all.

Under these circumstances, it is extremely unwise and dangerous to make statements as follows without warning against the hazard involved:

"If the blades are readily accessible carbon tetrachloride will dissolve most grease-based residues. . . . . Carbon tet can be applied with a spray gun or paint brush."

"For ducts much larger than 24 in. square the most effective method is to get inside and do the job by hand with carbon tet, scrapers, a vacuum cleaner, or whatever is expedient for the case at hand."

Spraying of carbon tetrachloride on fan blades and inside the fan housing and even brushing it on in most instances, and cleaning ducts by getting inside and using carbon tetrachloride can be done safely *only* if the man doing the work wears an adequate supplied-air respirator or in some instances an organic vapor gas mask.

It must not be inferred, however, that carbon tetrachloride is the only grease solvent that is harmful if inhaled. It is probably the most toxic of the group, but most proprietary grease solvents are quite toxic and should not be used for cleaning fans, ducts, or other ventilating equipment unless the man doing the work is properly protected.—A.D.B.

TESTING STEEL FLANGES

The July issue of HPAC (page 77) indicates that in the tests of steel flanges performed for the Heating, Piping, and Air Conditioning Contractors National Association, the strength of the flange (at the threads) was found to be as low as 6 percent of the pipe strength where poor threading was used. Inasmuch as I have been directly involved in these tests, I would like to point out that the 6 percent value applies to carefully made joints with threaded flanges having good threads.

Incidentally, this cyclic testing of steel flanges was undertaken by the research committee of the HPAC-CNA at the request of the American Standards Association, rather than the American Society of Mechanical Engineers as stated in the July issue.—J. D. Mattimore, chief engineer, product engineering and research, Tube Turns, Inc.

L. C. STONE RECEIVES RENSSELAER MEDAL

Rensselaer Polytechnic Institute has awarded its 1948 Demers medal to Leverett C. Stone, Washington, D. C. The medal is awarded annually by RPI's trustees in recognition of distinguished service for the college by an alumnus.

Mr. Stone was graduated at RPI as an electrical engineer in 1914 and is now a partner in the Stone Heating and Ventilating Co.

SAM LEWIS' PAGE

Informal comment on heating, piping, and air conditioning matters is given in this regular feature by Samuel R. Lewis, consulting mechanical engineer, member HPAC's board of consulting and contributing editors

Heating Questions Range from Sublime to Ridiculous

. . . . . and who am I to place each one in its proper bin?, asks Mr. Lewis in introducing this easy-to-read discussion of some of the considerations involved in applying radiant heating to new and old buildings. He winds up by dedicating one of his inventions to the public—as did Ben Franklin

NEARLY EVERY DAY telephones or callers bother me about radiant heating. This subject is ever interesting to discuss, but the questions and the answers embarrass me by disclosing my ignorance. The questions range from the sublime to the ridiculous . . . . . and who am I to place each one in its proper bin?

It is easy enough to approve warm water pipes of iron or copper, proper in area, imbedded in the floor or in the ceiling of a conventional room. It is easy to insist that they shall be insulated and isolated to some extent for serving that room alone.

However, a proposal is made to install the hot water pipes within the solid concrete slab between the first and second stories of a structure. The genius who proposes this alleges that since people will occupy the building as a whole, any means for individual temperature control of the separate rooms is unnecessary and wasteful. I reply that I was brought up in the school of radiators with radiator valves, and of warm air registers with dampers in them . . . . . yet I reflect that in my own two story home a radiator valve very rarely is opened or closed. I argue that the second story rooms, warmed through their floors, may become too warm before the first story rooms, receiving heat from overhead, are comfortable . . . . . yet I remember plenty of two story homes warmed by thermally circulating warm air in which the upstairs registers rarely are closed and in which all recirculated air flows down through the stairways to return grilles in the first floor and in which people live out their fairly happy lives.

The genius says that I am extravagant and hidebound if I insist on individual room control in any ordinary building; that insulation above the overhead radiant pipe coil to isolate the heating effect to that particular room is unnecessary. My reaction is to question myself as to whether I have been too conservative.

I must admit that radiant heat transmission is successful in well designed plants, whether the heat comes from overhead or from underfoot. It does not seem to matter whether the heat emanates from iron or steel or copper or from electric wires.

Radiator or Convector for Control

A thought obtrudes itself as to whether the ultimate answer may appear in temperance; that is, perhaps the rooms could be heated somewhere near the desired degree by radiant means serving the whole project at one water temperature, and then be given the final balance of control by some easily manipu-

lated different heat transmitter—such as a radiator or convector or baseboard unit. This would be a more intelligent answer than to overheat the whole institution and to achieve individual comfort by opening a window to waste the excess fuel—as is often done.

Questions constantly are being propounded about whether radiant heating will be successful if forced to operate through a wood floor, rugs, etc.; also, whether the scheme will be defeated if acoustical plaster or gypsum plaster or some special type of snapped-in or pasted-on acoustical ceiling pad shall be used. I have a few guinea pigs myself, such as some rooms where the effect of a wooden ceiling below radiant pipe coils is being observed. I have considerable testimony about the action of copper coils under maple floors.

Not Many Trouble Jobs

A remarkable quality of radiant heating seems to be that I have not been called in on many trouble jobs. There are, of course, some careless steamfitters. I have seen thin copper tubing apparently broadcast with great abandon over the wood forms prior to pouring concrete. The tubing is hammered by wheelbarrows, jammed by falling brick and tools, and subject to careless nail driving—yet seems to survive and the job works. I have seen necessity for replastering and repainting in a new overhead radiant heating plant because they allowed the oil burner to run wild and to heat the new and still-damp construction to something like 230 deg.

I have seen radiant piping systems that required a considerable amount of balancing for temperature and extra venting for air, but on the whole the mechanically circulating hot water seems to go where it is needed and the steamfitter's skill, such as used to be so necessary with thermally circulated water, may be discounted somewhat.

There is little experience as to radiant heating applied to old buildings. I believe that this method of heat transmission is sufficiently advantageous that eventually I may have the fun of applying it to an old one. Certainly I would not be afraid to do so, but very likely it would mean an overhead job with new ceilings. Perhaps we shall see a prefabricated slab, comprising an insulated top, the imbedded heat coils or wires, and an attractive looking bottom delivered by truck and rapidly bolted in place against the old ceiling. I invented such a radiator long ago, but have just been too busy to put it into production. I hereby dedicate it to the public, following the object lesson of Benjamin Franklin who did just this with his stove that obsoleted fireplaces as a method of heating.

Hospitals, High Schools Head Catholic Program

The Catholic church will spend more money for new hospitals and high schools than any other type of building in the next 10 years. Churches are third.

This was announced at the completion of a nationwide Catholic building survey begun last fall among pastors, religious superiors, and college officials by the business and industry foundation of the college of St. Joseph's of Indiana.

The foundation made the survey in connection with the National Catholic Building Convention and Exposition which St. Joseph's sponsored last month in Chicago.

With information on 1534 building programs, the college foundation has estimated that the church will spend $10 billion in the next decade on U. S. construction, remodeling, furnishing, equipment, and maintenance.

Grade schools and college buildings will be about equal in Catholic building expenditures. There will be more for recreation centers than convents, and twice as much for convents as for priests' homes.

The average Catholic hospital will cost $1,168,237; college building, $535,877; high school, $471,446; grade school, $136,892; recreation center, $135,581; church, $123,762; convent, $82,881; and rectory, $35,509.

Samuel R. Lewis, consulting engineer, Chicago, a member of HPAC's board of consulting and contributing editors, spoke on heating and air conditioning the Catholic building at the convention, and cited advantages of radiant heating.

George F. Denniston, executive manager, Eggers and Higgins, New York architects, discussed the administrator, architect, and contractor. He forcefully told delegates not even to buy property without consulting their architect, and that a building project which formerly could be completed in one year now requires 18 months to two years.

"Building superintendents and janitors, dealing with maintenance, are important men," he said. "They should be well qualified and properly paid. Hire them three to four months before doors open, to enable them to pick up valuable 'know-how' from contractors.

Watch Out for "Building Boners"

"Here are typical 'building boners' to beware of," he concluded: "(1) Forgetting to change a ventilating system filter for more than a year when it should have been replaced every two weeks. (2) Hiring engineers at a cost of $12,000 to tear out and investigate a faulty ventilating system, only to learn that the janitor didn't know how to turn it on. (3) Putting a hospital's air conditioning system through the ventilating shaft, spreading kitchen odors throughout the building. (4) Having accoustics so perfect that even the telephones couldn't be heard ringing."

Kenneth K. Stowell, editor in chief of the Architectural Record, spoke on when conditions will be "right" for building.

"To my mind, the greatest need in today's world is personal religious faith and personal integrity," Mr. Stowell declared. "Buildings which contribute to this need are of utmost importance now before other forces break down moral fiber. Modern construction costs are high but so are the moral stakes."

Heating, Piping & Air Conditioning

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Journal Section

Comparison of Physiological Adjustments of Human Beings During Summer and Winter

By Nathaniel Glickman*, Tohru Inouye**, Robert W. Keeton, M.D.†, Chicago, Ill. and Maurice K. Fahnestock††, Urbana, Ill.

This paper is the result of research sponsored by the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS in cooperation with the University of Illinois, College of Medicine.

SUMMARY—The tests described are studies on the rapidity and magnitude of physiological adjustments made by the body, at rest, on exposure to sudden changes of environmental temperature and humidity during the winter months. Comparisons are made with similar tests conducted in summer. Four healthy male medical students ranging in age from 19 to 23 years were used as subjects, three being the same who were used in summer tests.

After 1 hour exposure to a *comfortable* environment, reactions were the same in summer and winter. The comfort impression on entering a *comfortable* room was higher in winter than in summer.

After 1 hour in the hot room, mean skin temperature was the same in winter and summer, but rectal temperature increased slightly more in winter. Perspiration was greater in summer, although the time of appearance on the subject was the same.

Introduction

STUDIES of the rapidity and magnitude of physiological adjustments made by the body on exposure to sudden changes in environmental temperature and humidity during the summer months of 1946 have been reported[1]. These studies were extended to the winter months of 1946-47.

The purpose of the present paper was to determine whether the adjustments of these subjects differed in the winter from those reported for the summer. If differences occurred not attributable to experimental conditions, they would represent seasonal alterations in the subject's response.

The entire problem of seasonal adaptation has been under study by many investigators over a long period of time. However, many of the changes observed are not relative to this study. It has been stated that certain seasonal adjustments occur. MacLean and Partridge[2] have reported higher skin temperatures in the summer than in the winter under equilibrium conditions and a greater increase in skin temperature in the winter than in the summer when the room temperature was elevated during the test. Winslow[3] et al have reported that the sweat secreting mechanism appears to be in more effective working order during the summer than during the winter although mean skin and rectal temperatures were not different under equilibrium conditions. Houghten[4] et al reported a greater increase in rectal temperature in the winter than in the summer of men engaged in light work at comparable Effective Temperatures.

Subjects

Four healthy male medical students, ranging in age from 19 to 23 years were subjects for the experiments. These included three of the

*Assistant Professor of Medicine and Research Physiologist, Department of Medicine, University of Illinois. Member of ASHVE.

**Research Assistant, Department of Medicine, University of Illinois.

†Head, Department of Medicine, University of Illinois. Member of ASHVE.

††Assistant Director, Engineering Experiment Station, Department of Mechanical Engineering, University of Illinois. Member of ASHVE.

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[1]Exponent numerals refer to References.

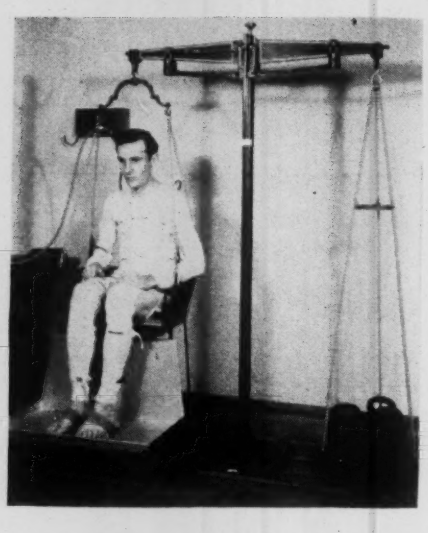

Fig. 1—Subject wearing thermocouple union suit and seated in a Troemner balance

five subjects previously studied in the summer of 1946 and an additional subject who was studied during the winter of 1946-47 and the summer of 1947. Their physical measurements are presented in Table 1.

Procedure, Experimental Conditions and Observations

The procedure and experimental conditions were the same for the summer and winter studies and have been described[1] in detail in the previous paper. After the subject had remained seated in the outer office for about 20 min he entered the comfortable room (designated comfortable room CR 1), immediately reported his *comfort* vote and began disrobing. He was weighed on a Troemner balance in the nude wearing only wooden sandals of known weight and then dressed in the thermocouple union suit (90 percent cotton, 10 percent wool). He resumed his seat on the balance, Fig. 1, and remained sitting quietly until one hour had elapsed from the time of entrance into the comfortable room. He then walked into the hot room and sat quietly in a second Troemner balance for one hour after which he returned to the comfortable room (designated comfortable room CR 2) and sat quietly in the first balance for one hour. Experiments were obtained with each subject at three different relative humidities in the comfortable room, both in the summer and in the winter.

The comfortable room was maintained at a constant dry bulb temperature of 76 F ± 0.5 deg with water vapor pressures of 0.133, 0.267 and 0.356 psi corresponding to relative humidities of 30, 60 and 80 percent (Effective Temperatures of 68.8, 71.5 and 73.4 ET, respectively). The hot room, immediately adjoining the comfortable room, was maintained at a dry bulb temperature of 98.5 F ± 1.0 deg with water vapor pressure of 0.599 ± 0.036 psi corresponding to a relative humidity of 66 ± 4 percent (90.2 ET).

Globe thermometer readings in the comfortable room were the same in the summer and in the winter. Globe thermometer readings in the hot room averaged 98.0 F and 96.8 F in the summer and in the winter, respectively. This difference was to be expected since the one outside wall had five double pane windows.

The average, maximum, minimum, and mean monthly outside temperatures for Chicago as reported by the Weather Bureau of the United States Department of Commerce are presented in Fig. 2. These values are for the summer of 1946 and the winter of 1946-47.

Observations included skin and rectal temperatures, evaporative weight loss, time of onset of perspiration, pulse rate, and subjective sensation of warmth or coolness.

Statistical Analysis of the Data

The data were treated by setting up paired comparisons for each subject for summer and winter; *i.e.*, the values at the same ambient conditions were compared. The paired differences at water vapor pressures of 0.133, 0.267 and 0.356 psi were then combined regardless of vapor pressure. Student's[5,6] method and tables designated for determining the significance of the mean of a small series of paired differences were used. Differences were considered significant when the probability (P) was less than 0.030.

Results

A comparison of the mean values for summer and winter under comfortable conditions with the subjects in equilibrium with the environment (comfortable room CR 1) are shown in Figs. 3 and 5 and revealed the following: the final values for the mean skin temperature (MT_s) averaged 92.77 F in the summer and 92.90 F in the winter (Fig. 3); the final rectal temperature (T_r) averaged 98.14 F in the summer and 97.88 F in the winter (Fig. 3); the final pulse rate averaged 81.8 and 79.5 beats per minute in the summer and winter, respectively (Fig. 5); the mean rate of evaporative weight loss averaged 0.827 and 0.789 grams per minute in the summer and winter, respectively (Fig. 5); and the comfort vote averaged 4.1 and 4.4 in the summer and winter, respectively (Fig. 3). All of these differences are small and are not statistically significant.

The comfort vote on entrance into comfortable room CR 1 averaged 4.0 and 4.3 in the summer and winter respectively. This difference, though small, is statistically significant (P = 0.014). It must be remembered that the subjects had been sitting in an outer office for about 20 min and this vote was obtained

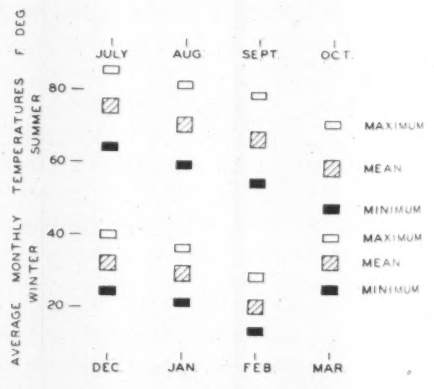

Fig. 2—Average maximum, minimum and mean monthly outside temperatures for the summer of 1946 and the winter of 1946-47 for Chicago as reported by the Weather Bureau

Table 1—Description of the Experimental Subjects

Subject	Age Yrs	Height Ft & In.	Weight Lb	Area Sq Ft
J. B.	23½	5 11¾	138	19.5
E. M.	22½	6 2¼	150	21.0
M. B.	20	5 8½	134	18.6
B. K.	22	5 9	133	18.8

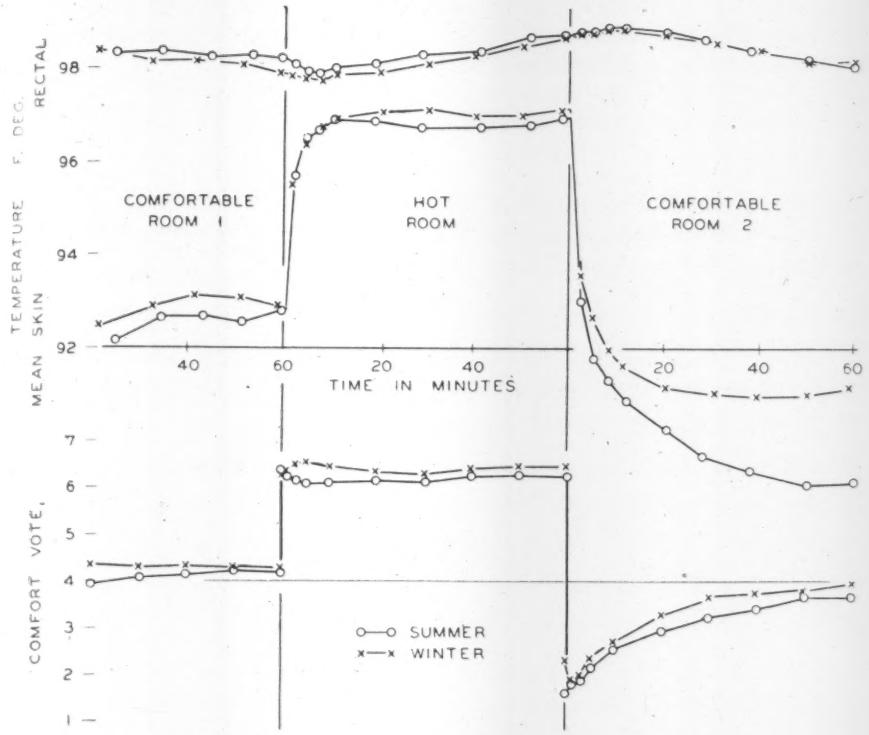

Fig. 3—Averages for rectal and mean skin temperature and comfort vote during summer and winter in comfortable room CR1, hot room, and comfortable room CR2

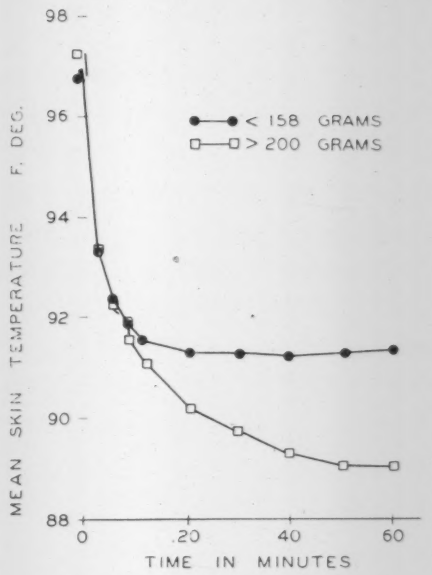

Fig. 4—Average mean skin temperature response in comfortable room CR2 for groups with large and small amounts of moisture in the union suit and on the skin at time of entrance

immediately on entrance into comfortable room CR 1 with the subjects normally clothed.

This difference between summer and winter in the subjective sensation of warmth on entrance into the comfortable room has several possible explanations. It might be expected that subjects would respond with slightly higher comfort votes in the winter than in the summer for the same Effective Temperature (ET) since it has been stated that the summer comfort zone is higher than the winter comfort zone[7]. On the other hand, the office in which these subjects were seated prior to entering the comfortable room was certainly at a higher temperature in the summer than in the winter. Thus, in the summer the subjects would enter the comfortable room from a higher ambient temperature; whereas, in the winter the difference would be slight and in the opposite direction. In addition, the outer clothing of the subjects may have been slightly heavier in the winter. These factors cannot be ignored and, unless they are carefully controlled, interpretations of such differences are conjectural. Nevertheless, such uncontrolled conditions do exist normally and probably account for many of the differences in observed subjective sensations.

Mean Skin Temperature

The rapidity and magnitude of the increase in mean skin temperature on entering the hot room were strikingly similar for both summer and winter experiments (Fig. 3). The maximum difference between the means did not exceed 0.4 F deg during the hour. Thus, cutaneous vasodilatation occurs as rapidly and as completely in the winter as in

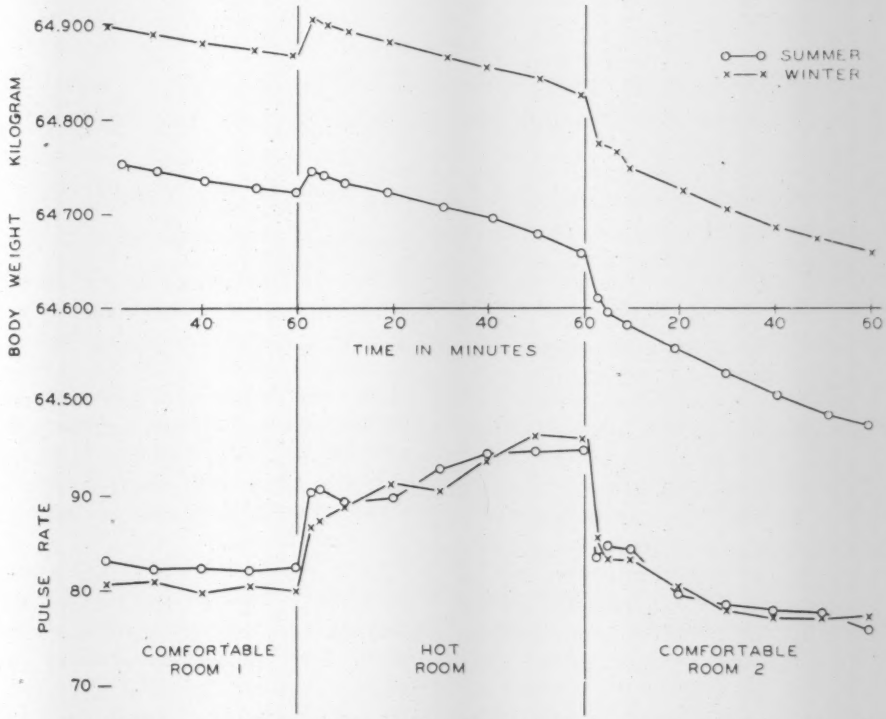

Fig. 5—Averages for body weight and pulse rate during summer and winter in comfortable room CR1, hot room, and comfortable room CR2

the summer on exposure to this high environmental temperature. In comfortable room CR 2, after the hot room exposure, the change in mean skin temperature showed a distinctly different trend between summer and winter values. No statistically significant differences in the decrease in mean skin temperature appeared until 10 min after entering comfortable room CR 2. At 10 min the decrease averaged 5.78 F deg in the summer and 5.26 F deg in the winter. This difference of 0.52 F deg was significant ($P = 0.013$). At 20 min the difference was 0.77 F deg ($P = 0.022$) and was 2.04 F deg ($P = 0.004$) at the end of the hour. Thus, the difference became progressively greater during the hour.

The difference in mean skin temperature response between summer and winter is not to be construed as evidence of seasonal adaptation. As will be discussed later, the subjects perspired more in the hot room in the summer than in the winter, and it is this greater amount of moisture present in the union suit in summer which is the dominant factor in causing the observed differences in mean skin temperature. It is probable that had the period of exposure been prolonged beyond one hour the differences would have become less and less until no difference existed some time after the excess moisture in the union suits had been evaporated.

In two of the 12 paired comparisons the mean skin temperature decreased more in the winter than in the summer, and in these two experiments it was noted that the subjects entered comfortable room CR 2 with more moisture present in the union suit in the winter.

Therefore, the effect of the amount of moisture present in the union suit, on entrance into comfortable room CR 2, on the mean skin temperature was assessed further. The experiments were divided into two groups regardless of season, *i.e.*, Group I, in which the moisture exceeded 200 gms (average 244 gms) and Group II, in which it was less than 160 gms (average 123 gms). It can be seen (Fig. 4) that the mean skin temperature continues to decline during the first 50 min in Group II, whereas, it has become practically stabilized after the first 20 min in Group I. This does not prove conclusively that seasonal adaptation is not present, but does show that the amount of moisture in the union suit is most important in affecting the mean skin temperature under these experimental conditions.

Rectal Temperature

The statistically significant decrease in rectal temperature reported in the summer series[1] which occurred within 10 min of entering the hot room was also observed during the winter series (Fig. 3). There was no significant difference in the magnitude of this decrease between the summer and winter values.

The final rectal temperature in the hot room (Fig. 3) averaged 98.71 F in the summer and 98.63 F in the winter. However, the increase in rectal temperature from the final comfortable room CR 1 value to the final hot room value averaged 0.57 F deg and 0.75 F deg in the summer and winter, respectively. This difference of 0.18 F deg, though small, was statistically significant ($P = 0.010$).

There were no differences between the summer and winter values in the changes in rectal temperature which occurred in comfortable room CR 2 (Fig. 3). The increase which occurred within the first 10 min was the same for both the summer and winter series. Also, the decrease which occurred during the final 40 to 50 min was strikingly similar.

Perspiration and Evaporation

The time of appearance of visible perspiration in the hot room in the winter varied from one subject to another and in the same subject from one experiment to another, just as it did in the summer[1]. The average time was 10.8 and 11.9 min in the summer and winter, respectively (Fig. 3). This difference was not significant.

The amount of perspiration which occurred in the hot room could not be measured directly since the subjects did not evaporate the perspiration as rapidly as it appeared.

Perspiration (P) in the hot room was estimated as the difference between the total weight loss (W_T) and the average normal weight loss (W_N). That is

$$P = W_T - W_N$$

where

W_T = difference between initial and final nude weights in comfortable rooms CR 1 and CR 2 respectively.

$$W_N = \frac{w}{t_w}(t_1 + t_2)$$

w = difference between first and final weights of clothed subject in comfortable room CR 1

and

t_w = time interval for w

t_1 = time from initial nude to final weight in comfortable room CR 1

t_2 = time from entrance to final nude weight in comfortable room CR 2

A comparison of the summer and winter values revealed that in nine of the twelve paired comparisons the subjects perspired more in the hot room in the summer than in the winter. In the summer, perspiration averaged 303.0 gms, and in the winter averaged 188.3 gms ($P = 0.022$). This difference of over 114 gms is reduced to only 63 gms if the data obtained from one experiment is omitted. In this experiment in the summer the subject perspired about three times as much as in any of his other experiments. The difference of 63 gms (266 gms in summer and 203 gms in winter) is still statistically significant ($P = 0.022$).

Even though the subjects perspired more in the hot room in the summer than in the winter, the average evaporation was about the same (90.1 and 81.7 gms in the summer and winter, respectively). On entering the hot room, however, an average of 15.8 gms more ($P = 0.013$) moisture was adsorbed by the union suits in the winter than in the summer. This reduced the difference in moisture available for evaporation between summer and winter during the hot room exposure and probably accounts for the absence of a significant difference in the average evaporation in the hot room. The authors are unable to offer a satisfactory explanation for the difference in moisture adsorbed in the hot room at this time. It is possible that a change in texture of the union suits occurred

after the extensive use of the preceding summer.

The approximate amount of moisture in the union suit and on the skin on entrance into comfortable room CR 2 (after the hot room exposure) averaged 251 gms in the summer and 162 gms in the winter. In three of the 12 paired comparisons it was greater in the winter. The difference of 89 gms was reduced to 44 gms by omitting the experiment in which the subject perspired profusely. The differences, however, were not statistically significant.

The average amount of moisture evaporated in comfortable room CR 2 was 172 and 163 gms in the summer and winter, respectively. The difference was not significant. However, in eight of the 12 paired comparisons a greater amount was evaporated in the summer. In three of the other four paired comparisons, in which the subjects evaporated more in the winter, it was noted that the union suits on entrance contained a greater amount of moisture in the winter. Therefore, the data were subjected to further analysis. The amount of moisture in the union suit on entrance definitely affected the total evaporation ($r = +0.81$) in comfortable room CR 2 regardless of season and variables influencing evaporation. In a manuscript now in preparation for publication the authors have demonstrated that evaporation under dynamic conditions (comfortable room CR 2) is proportional directly to the gradient of water vapor pressure from the skin to the ambient environment, the amount of moisture available for evaporation, the calculated surface area and time, and inversely to the total pressure.

The residual moisture in the union suit* at the termination of the experiment (comfortable room CR 2) average 40.3 gms more ($P = 0.013$) in the summer than in the winter. As would be expected, in the three experiments in which the subjects perspired more in the winter and had a greater amount of moisture in the union suit and on the skin on entrance into comfortable room CR 2, there was also a greater amount of moisture in the union suit at the termination of the experiment.

*Obtained by taking the difference between the initial and final weight of the union suit.

Pulse Rate

The pulse rates responded similarly in the summer and winter when the subjects were in the hot room and comfortable room CR 2 (Fig. 5). No real differences between summer and winter values occurred at any time during the experiment.

Comfort Vote

The subjective sensation of warmth on entering the hot room was about the same in summer and winter (Fig. 3). However, five minutes after entering the hot room the comfort vote was higher ($P = 0.028$) in the winter than in the summer and continued to remain higher ($P = 0.029$) for the next five minutes only. In other words, after the initial response, the degree of warmth experienced in the winter was greater for about 10 min. After 10 min there were no differences in sensations of warmth between summer and winter.

The comfort vote on entering comfortable room CR 2 (Fig. 3) indicates that the subjects felt distinctly ($P = 0.017$) cooler in the summer than in the winter, an average of 1.6 and 2.3 respectively. Following this initial response the comfort votes were not significantly different in the summer and winter, even though the mean skin temperature was distinctly lower in the summer. In this connection, as mentioned in the previous paper[1] the mean skin temperature at the time of comfort votes of "4" ranged from 87.6 to 92.3 F deg in comfortable room CR 2.

The decrease in mean skin temperature, as previously mentioned and as shown in Fig. 3, was not significantly different within the first ten minutes for summer and winter, and there was no difference in the amount of moisture evaporated (Fig. 5). This supports the evidence that the significant difference in entrance comfort vote was due to seasonal adjustment. The subjects were accustomed to large temperature contrasts in the winter.

An analogous situation which is a common experience is illustrated by the following: On going outdoors in the winter one notices the cold more when the weather suddenly changes to 30 F following a period of mild weather, *e.g.*, 50 F than following a period of cold weather, *e.g.*, 10 F. Similarly, in the summer one feels warmer at 85 F following a period when the temperature remains about 70 F than following a period of hot weather, *e.g.*, 100 F.

Discussion

In comfortable conditions with the subjects in equilibrium with the environment no evidence of seasonal differences was obtained. This is in accord with the findings of Winslow, Herrington and Gagge[3]. They reported no seasonal differences for either nude or clothed subjects in rectal and mean skin temperatures and metabolism. Yaglou and Messer[4] reported no seasonal differences in the range of skin temperature associated with comfort. On the other hand, MacLean and Partridge[2] reported higher final skin temperatures (three areas on the body) in the summer than in the winter on two subjects and interpreted this as a seasonal difference. Fortunately, they included a table giving air and wall temperatures in the summer and winter. An examination of this table revealed that for the experiments at an air temperature of 75 F (71 ET) the wall temperature was 78 F in the summer and 73 F in the winter; for the experiments at an air temperature of 70 F (67 ET) the wall temperature was 75 F and 70 F in the summer and winter, respectively. Thus, for the experiments at both 75 and 70 F the wall temperatures were 5 F deg higher in the summer than in the winter. This discrepancy accounts, in part, for the observed differences in skin temperature.

In the present study when the subjects entered the hot room mean skin temperatures increased as rapidly in the winter as in the summer and the values at the end of the hour were the same. Again, the data presented do not agree with the findings of MacLean and Partridge[2]. They reported that the skin temperature increased more in the winter than in the summer after two hours in a hot environment (97 ET) which was preceded by one

and one half hours at either 67 or 71 ET. The wall temperatures were allowed to change normally as the air temperature of the room was elevated. An examination of Table 3 in their paper showed that the temperatures of the skin averaged 5.6 to 8.6 F deg lower in the winter than in the summer in the room at low Effective Temperature and averaged only 1.3 to 2.5 F deg lower in the winter in the room at high Effective Temperature. It appears that the greater increase observed in the winter occurred because of the much lower skin temperatures at the low Effective Temperature. This should not be considered as evidence of seasonal adaptation to overheating.

Teleologically, if definite seasonal adaptation were present, one might expect the mean skin temperature to decrease more rapidly on entering a cool or cold environment in the winter. This would be a protective action to decrease the heat loss from the body. Similarly, the mean skin temperature might be expected to increase more rapidly on entering a hot environment in the summer. This was not observed under the experimental conditions imposed. In the United States a large percentage of the people probably never attain a detectable physiological adaptation to winter conditions because very few hours of each day are spent outdoors and even then the individuals are warmly clothed. Evidence of seasonal adaptation might be expected in individuals who perform their daily tasks out-of-doors. It has been shown[9] that the rectal temperature decreases less during an 8 hour exposure to a cool environment (60 F) when preceded by several weeks of daily 8 hour exposures (5 days per week) to intense cold (—20 F). This adaptation to cold is largely dissipated in 17 days. Thus, in order to detect this sign of adaptation to cold it was necessary to observe the subjects in an environment which produced less of a thermal stress than the one which induced the adaptation.

The findings of Houghten, Rosenberg and Ferderber[4] showing a greater increase in rectal temperature in the winter than in the summer on exposure to the same ambient environment have been confirmed. MacLean and Partridge[2], on the other hand, reported no difference in increase of oral temperature between summer and winter. The four subjects in Houghten's study were engaged in light work and were exposed to the hot conditions for three hours. At an Effective Temperature of 90.0 deg the average increase was about 0.4 F deg greater in the winter for Houghten's subjects as compared with 0.18 F deg for the subjects in the present study.

In the study by MacLean and Partridge[2] no seasonal differences in pulse rate were observed after a two hour exposure to the hot environment. The greater increase in pulse rate in the winter reported by Houghten[4] et al should not be explained as seasonal adaptation. It merely reflects the higher rectal temperatures observed in the winter. The rectal temperature differences observed in the present study were too small to affect the pulse rate.

The subjects perspired more in the hot room in summer than in winter. This was also observed by Winslow, Herrington and Gagge[3] who reported that the sweat secreting mechanism appears to be in more effective working order during the summer than during the winter. Kuno[10] also reported similar findings. The time of appearance of visible perspiration is about the same in summer and winter. Adolph[11] reported no difference in the time of onset of sweating in two subjects during successive exposures that induced acclimatization to heat.

Summary of Tests and Results

Four healthy male medical students, clothed in 90 percent cotton union suits and wooden sandals, were subjects for three experiments each in the summer and three experiments each in the winter. The subjects remained in a comfortable room for a control period of one hour. The dry bulb temperature was maintained at 76 F for all experiments. The relative humidity was maintained at 30, 60 and 80 percent corresponding to water vapor pressure of 0.133, 0.267, and 0.356 psi respectively. The subjects then entered and remained in the hot room (98.5 F deg dry bulb, 6[illegible] percent RH) for one hour and then returned to the comfortable room for one hour. Thus, each subject was exposed to three different ambient environments in the comfortable room both in the summer and in the winter. The subjects remained seated in a Troemner balance in both rooms. Observations on rectal and skin temperatures, evaporative weight loss, pulse rate and comfort vote were obtained.

The data justify the following observations:

1. After one hour in the comfortable room (before the hot room exposure) no significant differences were observed between the summer and winter values at comparable relative humidities for final mean skin and rectal temperature, average rate of evaporative weight loss, pulse rate and comfort vote.

2. The comfort vote on entering the comfortable room from an uncontrolled environment was slightly, but definitely, higher in the winter than in the summer. This is not interpreted as evidence of seasonal adaptation.

3. In the hot room there were no significant differences observed between the summer and winter values for the increase in mean skin temperature, either at 10 min or after one hour, for the decrease in rectal temperature within the first 10 min, for the increase in pulse rate either initially or after one hour, and for the entrance comfort vote. After the entrance comfort vote, the degree of warmth experienced was slightly greater in the winter than in the summer only from five to 10 min.

4. The rectal temperature increased slightly, but significantly, more in the winter than in the summer after one hour in the hot room.

5. The subjects perspired significantly more in the summer than in the winter during the one hour exposure in the hot room. The time of appearance of visible perspiration was not significantly different.

6. In the comfortable room CR2 (after the one hour hot room exposure) the mean skin temperature decreased significantly more in the summer than in the winter. This difference was not primarily due to seasonal adaptation but was related to the amount of moisture present in the union suit.

7. In comfortable room CR2 there were no significant differences observed between summer and winter values for the maximal increase in rectal temperature within the first 10 min, for the decrease in rectal temperature during the hour, and for the decrease in pulse rate during the hour.

8. The average amount of moisture evaporated in comfortable room CR2 was shown to be definitely affected by

the initial amount of moisture present in the union suit regardless of season.

9. The comfort vote on entering comfortable room CR2 was definitely lower (cooler) in the summer than in the winter. Following the initial response, the comfort votes were not significantly different.

Conclusion

The alterations in the physiological adjustments were slight and gave little evidence that seasonal adaptations were important in determining the subject's responses. They were noted chiefly after the exposure to a hot environment in the winter and consisted of a transient but greater sensation of warmth, a larger rise in rectal temperature, and a smaller production of perspiration.

References

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JOURNAL SECTION

INDUSTRIAL EXHAUST AND VENTILATION

Increasing recognition by hygienists and engineers that engineering principles can be used to advantage in exhaust system ventilation to remove toxic fumes and gases, has led to reorganization of the Sectional Committee on Safety Code for Industrial Exhaust and Ventilation. This committee, organized under the procedure of the *American Standards Association*, is sponsored by the *International Association of Industrial Accident Boards and Commissions*. Theodore Hatch of the Industrial Hygiene Foundation is chairman of the reorganized committee. Mr. Hatch has been widely known for many years as an authority on ventilation for protection of the health of industrial employees.

The work of the committee is being planned around specific operations for which exhaust ventilation is needed rather than for the development of specifications by industries or for the equipment. Ten operations have been agreed upon as the basis for future work. They include mechanical cutting and abrading; surface coating; open tank operations; solid materials handling; fuel burning-exhaust gas producing operations; molten materials handling; welding, burning and soldering; fiber handling; volatile and gaseous material handling; and chemical process operations. This list was compiled by a subcommittee working under the leadership of A. C. Stern, Division of Industrial Hygiene and Safety Standards, New York State Department of Labor, who represents the *American Society of Mechanical Engineers* on the committee.

Sub-committees have already been appointed to start work on specifications for surface coating operations, open tank operations, and handling of solid materials.

In addition, a revision of an existing report outlining fundamentals affecting the design and operation of exhaust systems is now being prepared by a sub-committee headed by Dr. Allen D. Brandt, Industrial Hygiene Engineer, Bethlehem Steel Co., representing the *American Public Health Association*. This report, Fundamentals Relating to the Design and Operation of Exhaust Systems BZ9, was first issued in 1936 for trial use, and has been widely adopted since that time.

K. O. WILLIAMS APPOINTED REPRESENTATIVE

The appointment of K. O. Williams as direct factory representative of H. A. Thrush & Co., Peru, Ind., has been announced. Mr. Williams had been associated with the N. O. Nelson Co. for many years as assistant manager of the St. Louis branch and as a sales engineer. Mr. Williams, who has been very active in the heating industry, joined the ASHVE in 1944.

CHICAGO CONDITIONAIRE CO. FORMED

The Chicago Conditionaire Co., Chicago, Ill., has been formed by the partnership of W. L. Long and L. H. Streb. The new firm will act as distributors for Westinghouse Electric Corp., and will also have available a complete stock of Carrier room air conditioners, food freezers and commercial refrigeration equipment, as well as humidifiers and window ventilators.

Mr. Streb, a member of the ASHVE, was formerly a contracting engineer for the Charles E. Crone Co. Both Mr. Streb and Mr. Long have had a wide and varied experience in every phase of engineering.

L. Copeland Watts

L. COPELAND WATTS ELECTED PRESIDENT OF IHVE

L. Copeland Watts, new president of the *Institution of Heating and Ventilating Engineers,* London, England, and one of the outstanding engineers of England, was inducted into office February 11, 1948. Born in London, in 1898, he was educated in mechanical engineering at the City and Guilds Technical College, Finsbury, and at the City and Guilds (engineering) College, South Kensington, where he was awarded the degree of A.C.G.I. (associate, City and Guilds Institute) and received the Bramwell Medal for scholarship.

When in 1924, J. Roger Preston, a past president of the Institution, started his consulting engineering business, Mr. Watts joined him, and in 1936, became a partner in the firm of J. Roger Preston & Partners, consulting engineers, in which he is today sole active partner. Since he joined the organization, it has been responsible for the design and supervision of many large installations of heating, hot and cold water services, ventilation, air conditioning, steam and condensation services, and boiler house plant and equipment, with a total value of some £10,000,000. Mr. Watts became a member of *IHVE* in 1933 and in 1935 was elected to the Council, which he represents on the Ministry of Works Code of Practice Committee. He has also served on the Technical Education and Examinations Board, the Code of Practice, and other committees of the Institution, Mr. Watts is a member of the *Institute of Mechanical Engineers, Institute of Heating and Ventilating Engineers, Association of Consulting Engineers,* and is also a member of the ASHVE.

Connecticut Chapter Meets in Meriden

S. R. Osborne, retiring president, presenting Life Membership Certificate to Dr. C.-E. A. Winslow

(Seated) Dean L. E. Seeley, S. R. Osborne, Dr. C.-E. A. Winslow. *(Standing)* Winfield Roeder, D. M. Hummel, P. D. Bemis, W. K. Simpson, E. C. Marsden, L. A. Teasdale

S. R. Osborne, retiring president, presenting gavel to incoming president, E. C. Marsden

JOURNAL SECTION

Solar Heat Gain Through Walls and Roofs for Cooling Load Calculations

By James P. Stewart,* Syracuse, N. Y.

SUMMARY—A simplified method is presented for determining heat gain through walls and roofs due to combined effect of solar radiation and air temperature difference. This is accomplished by *tables of equivalent temperature differentials*, in which all types of building construction are grouped under a few classifications.

Introduction

THERE is a great need for quick reference tables to aid the engineer in making load calculations for air conditioning installations in order that the cooling load due to the solar heat gain through walls and roofs may be determined easily. Some experimental data have been obtained by Houghten et al, at the laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS. Several investigators have made analytical studies[1, 2, 3] of the complex problem of periodic heat flow through walls and roofs. After a review of the published data, the author decided to use the method[4] proposed by C. O. Mackey and L. T. Wright, Jr., because in addition to being in the author's opinion as reliable as any of the others, it included an approximate method which lends itself to practical solution.

This paper is written for the practicing engineer who has need for quick reference *tables*. It is not intended to give results which will completely satisfy those desiring accurate theoretical treatment. Some judgment and arbitrary adjustments were made as a necessary expedient in order to prepare practical time-saving *tables* at this time without waiting several years for the completion of other tests and analytical data which would make greater accuracy possible. These tables are intended for use in the interim period until theory and tests, particularly for roofs, can be brought into closer agreement.

There are many variables involved in determining the solar heat gain through a structure. Some are fairly well-known and others must be approximated. The major variables are as follows:

1. Outside air film coefficient of heat transfer.
2. Inside air film coefficient of heat transfer.
3. Thermal conductivity of material.
4. Density, specific heat and disposition of material.
5. Thickness of material.
6. Absorptivity of outside surface for solar radiation.
7. Time pattern of solar radiation intensity incident on any material.
8. Orientation of wall or roof.
9. Room air temperature.
10. Pattern of outdoor air temperature.
11. Hours of operation of cooling system.

The author made a comparison of the test values obtained by Houghten,[5, 6] et al. at the ASHVE Research Laboratory with calculated values obtained by a method proposed by Mackey and Wright.[4] The test values for walls agree fairly well with the theoretical calculations, but there is a large discrepancy between the test values and theoretical calculations for roofs, the test values being lower. A moderate inaccuracy can be tolerated in walls because this load is usually a small part of the total cooling load. Much greater accuracy is required for roofs because this load normally represents a large fraction of the total, particularly when the roof is sunlit.

The tables presented herein are based on theoretical calculations rather than on the experimental data, although some of the calculated values were modified after consideration of the test data.[5, 6] The following comments on the test data[5, 6] indicate the author's reasons for preferring theoretical calculations:

1. A study of the tests[5, 6] was made by taking the mean rate of the heat flow through the roofs over a 12 hour period and dividing by the average temperature difference between room air and the surface temperature as measured under the first layer of felt roofing. This resulted in an overall heat transmission coefficient which was about 40 percent lower than appears to be possible, even after correcting for omission of the outdoor surface heat transfer coefficient.
2. Nicholls' heat flow meters[5] were used for measuring the heat flow through walls and roofs and the accuracy of these observations is questioned. The heat flow meter consists essentially of a bakelite plate with thermocouples fastened on both surfaces. The temperature difference between the surfaces is a measure of the rate of heat flow through the plate. A good thermal contact between the bakelite plate and surface of wall or roof is most essential. During the tests it was necessary to recalibrate the heat flow meters.
3. The sunshine was not continuous during many of the tests[5, 6] conducted at Pittsburgh, and since no adequate mathematical method of adjustment was available, corrections were made on a judgment basis.
4. The inside surface film heat transfer coefficients are much less than normal for these tests, because apparently, the radiation component was much less due to other surfaces being at a higher temperature than the room air. In Fig. 8 of the paper[5] it will be noted that the resulting calculated inside film transfer coefficient is approximately 0.8 or 0.9 Btu per (hr) (sq ft) (F deg). The size and temperature of surrounding surfaces under most actual roofs should result in an inside coefficient substantially higher than that resulting from a test performed in a cubicle, 18 ft x 13 ft x 8 ft high.

*Engineer, Carrier Corp. Associate Member of ASHVE.

†Exponent numerals refer to References.

Presented at the Semi-Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Bretton Woods, N. H., June 1948.

The test[5, 6] data therefore appeared to be questionable and it was concluded that calculated values would be more conservative and should be used, particularly for roofs.

Application Data Methods Considered

The following methods were considered for determining the total sensible heat gain through walls and roofs:

1. *Equivalent Temperature Differential Method:* In this method the heat flow rate to the room can be obtained by multiplication of the overall heat transmission coefficient U by an *equivalent temperature differential.* The variation of the *equivalent temperature* from the mean sol-air temperature will be less than the variation of the sol-air temperature from the mean because of the damping or flywheel effect of heat storage in the structure.

For instance, in a very thick wall with large heat storage capacity the rate of solar heat flow into the room may be practically constant over the entire 24 hour period because of the flywheel effect. For this extreme case the *equivalent temperature differential* would be equal to the 24 hour mean sol-air temperature minus the room temperature. This decremental effect is the ratio of amplitude of the periodic surface temperature in room divided by the amplitude of the same periodic sol-air temperature on the exterior. This decremental effect is expressed by the factor $1.65\lambda_e/U$ where λ_e is the equivalent decrement factor as defined by Mackey and Wright,[4] and U is the overall heat transmission coefficient.

Note that for a very thin material having a low heat capacity the *equivalent temperature differential* at time of maximum heat flow into the room is approximately equal to the difference in the maximum sol-air temperature and room temperature.

2. *Total Heat Flow Method:* The rate of heat flow into the room per unit area for the different hours of the day may be expressed directly in Btu per hour

Table 1—Total Equivalent Temperature Differentials for Calculating Heat Gain Through Sunlit and Shaded Roofs

DESCRIPTION OF ROOF CONSTRUCTION[a]	SUN TIME / LOCAL TIME								
	8 A.M.	10 A.M.	12 N	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	12 M
LIGHT CONSTRUCTION ROOFS—EXPOSED TO SUN									
1" Wood[b] or 1" Wood[b] + 1" or 2" Insulation	12	38	54	62	50	26	10	4	0
MEDIUM CONSTRUCTION ROOFS—EXPOSED TO SUN									
2" Concrete or 2" Concrete + 1" or 2" Insulation or 2" Wood[b]	6	30	48	58	50	32	14	6	2
2" Gypsum or 2" Gypsum + 1" Insulation 1" Wood[b] or 2" Wood[b] or 2" Concrete or 2" Gypsum + 4" Rock Wool in Furred Ceiling	0	20	40	52	54	42	20	10	6
4" Concrete or 4" Concrete with 2" Insulation	0	20	38	50	52	40	22	12	6
HEAVY CONSTRUCTION ROOFS—EXPOSED TO SUN									
6" Concrete	4	6	24	38	46	44	32	18	12
6" Concrete + 2" Insulation	6	6	20	34	42	44	34	20	14
ROOFS COVERED WITH WATER—EXPOSED TO SUN									
Light Construction Roof with 1" Water	0	4	16	22	18	14	10	2	0
Heavy Construction Roof with 1" Water	—2	—2	—4	10	14	16	14	10	6
Any Roof with 6" Water	—2	0	0	6	10	10	8	4	0
ROOFS WITH ROOF SPRAYS—EXPOSED TO SUN									
Light Construction	0	4	12	18	16	14	10	2	0
Heavy Construction	—2	—2	2	8	12	14	12	10	6
ROOFS IN SHADE									
Light Construction	—4	0	6	12	14	12	8	2	0
Medium Construction	—4	—2	2	8	12	12	10	6	2
Heavy Construction	—2	—2	0	4	8	10	10	8	4

[a] Includes 3/8 in. felt roofing with or without slag. May also be used for shingle roof. [b] Nominal thickness of the wood.

Equation: {Total heat transmission from solar transmission and temperature difference between outside and room air. Btu per (hr) (sq ft) of roof area} = {Temperature differential from above table} × {Heat transmission coefficient for summer Btu per (hr) (sq ft) F deg}

1. **Source.** Calculated by Mackey's method (see reference list) and adjusted after studying ASHVE original test data. Estimated for July in 40 deg north latitude. For typical design day where the maximum outdoor temperature is 95 F and minimum temperature at night is 75 F (daily range of temperature, 20 F) mean 24 hour temperature 84 F for a room temperature of 80 F. All roofs have been assumed a dark color which absorb 90 percent of solar radiation, and reflect only 10 percent.

2. **Application.** These values may be used for all normal air conditioning estimates; usually without correction, in latitude 0 deg to 50 deg north or south when the load is calculated for the hottest weather. Note 5 explains how to adjust the temperature differential for other room and outdoor temperatures as well as for intermediate seasons when solar radiation is different.

3. **Peaked Roofs.** If the roof is peaked and the heat gain is primarily due to solar radiation, use for the area of the roof, the area projected on a horizontal plane.

4. **Attics.** If the ceiling is insulated and if a fan is used in the attic for positive ventilation, the total temperature differential for a roof exposed to the sun may be decreased 25 percent.

Table 1 *(Continued)*

5. **Corrections.** ***For temperature difference when outdoor maximum design temperature minus Room is different from 15 F.*** If the outdoor design temperature minus room temperature is different from the base of 15 F, correct as follows: When the difference is greater (or less) than 15 F add the excess to (or subtract the deficiency from) the above differentials.

For outdoor daily range of temperature other than 20 F. If the daily range of temperature is less than 20 F, add 1 deg for every 2 deg lower daily range; if the daily range is greater than 20 F, subtract 1 deg for every 2 deg higher daily range. For example, the daily range in Miami, Florida is 12 F or 8 deg less than 20 F, therefore, the correction is + 4 F at all hours of the day.

Light Colors. Credit should not be taken for light colored roofs except where the permanence of the light color is established by experience, as in rural areas or where there is little smoke. When the exterior surface of roof exposed to the sun is a light color, such as white or aluminum (which absorb approximately 50 percent and reflect 50 percent of the solar radiation) add to the temperature differential for roof in shade 55 percent of the difference between the roof in sun and roof in shade. When the roof exposed to the sun is a medium color such as light grey, blue or green, or bright red, add 80 percent of this difference.

For solar transmission in latitudes other than 40 deg north; and in other months. The table values of temperature differentials will be approximately correct for a roof in the following months:

NORTH LATITUDE		SOUTH LATITUDE	
Latitude (deg)	Months	Latitude (deg)	Months
0	All Months	0	All Months
10	All Months	10	All Months
20	All Months except Nov, Dec, Jan	20	All Months except May, June, July
30	Mar, Apr, May, June, July, Aug, Sept	30	Sept, Oct, Nov, Dec, Jan, Feb, Mar
40	April, May, June, July, Aug	40	Oct, Nov, Dec, Jan, Feb
50	May, June, July	50	Nov, Dec, Jan

For other months, the total temperature differential (t_x) may be approximated by the use of the following formula:

$$t_x = t_s + \frac{I_x}{I_y}\,(t_v - t_s)$$

where t_s = temperature differential for the same wall in shade for desired time of day; obtained from above table.

I_y = maximum solar transmission through glass, Btu per (hr) (sq ft) for flat skylight in July, 40 deg north latitude (*Note:* this is maximum value irrespective of time).

I_x = same as I_y except use the maximum value for flat skylight, for month, and latitude desired for t_x.

t_v = temperature differential for particular roof exposed to sun for the desired time of day from above table.

(*Note that this makes adjustment only for solar radiation and that there may be additional correction for outdoor temperature.*)

for a specific construction. This method has been generally used in the recent issues of THE HEATING, VENTILATING, AIR CONDITIONING GUIDES.

3. *Component Factor Method:* This method requires the multiplying together of several factors to obtain the rate of heat flow per unit area. These factors are solar radiation intensity, solar absorptivity, and fraction of solar energy absorbed on outer surface which eventually gets into the room.

Equivalent Temperature Differential Method Recommended

The equivalent temperature differential method of estimating the solar heat gain is recommended because it seems to be the best for universal application. It includes both the solar heat gain and the heat gain due to air temperature difference. *Equivalent temperature differentials* calculated for walls and roofs are listed in Tables 1 and 2 and are based on design values of solar radiation intensity shown in Fig. 1. Calculations were made by use of alignment charts such as Figs. 2 and 3.

The total sensible heat gain Btu per (hour) (square foot) which is that due to solar transmission plus that due to the temperature difference between the outside air and room air, is found directly by multiplying the *equivalent temperature differential* from Table 1 for roofs (or from Table 2 for walls) by the overall heat transfer coefficient U from Tables 3 and 4 or from THE GUIDE. U is expressed in Btu per (hour) (square foot) (Fahrenheit degree temperature difference between outside and inside air).

The regular overall heat transmission coefficient U for winter *may* be used with Table 1 to determine the rate of heat flow through *roofs*, but it is recommended, however, that summer coefficients be used. There will be little difference for *roofs* having very small overall coefficients, but there will be considerable difference for *roofs* having larger overall coefficients. Tables 3 and 4 for roofs may be used to obtain the summer coefficients directly for a number of typical constructions. These values have been prepared using an inside film heat transmission coefficient of 1.2. The overall coefficients for winter are also shown in these same tables. No distinction is made between winter and summer coefficients for walls because there is little difference in these values.

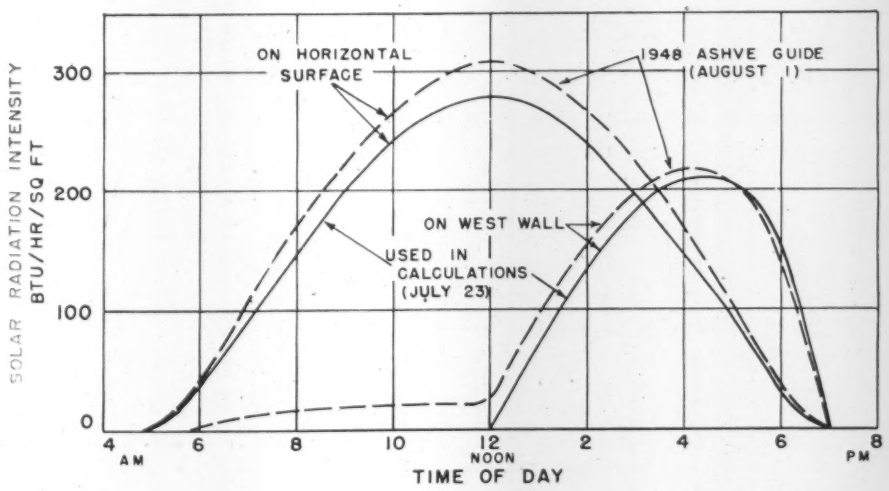

Fig. 1—Design valves of solar radiation intensity used in preparing tables

Table 2—Total Equivalent Temperature Differentials for Calculating Heat Gain Through Sunlit and Shaded Walls

North Latitude Wall Facing	SUN TIME: 8 A.M.		10 A.M.		12 N		2 P.M.		4 P.M.		6 P.M.		8 P.M.		10 P.M.		12 M		South Latitude Wall Facing
	LOCAL TIME																		
	Exterior color of Wall—D = dark, L = light																		
	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	
FRAME																			
NE	22	10	24	12	14	10	12	10	14	14	14	14	10	10	6	4	2	2	SE
E	30	14	36	18	32	16	12	12	14	14	14	14	10	10	6	6	2	2	E
SE	13	6	26	16	28	18	24	16	16	14	14	14	10	10	6	4	2	2	NE
S	-4	-4	4	0	22	12	30	20	26	20	16	14	10	10	6	6	2	2	N
SW	-4	-4	0	-2	6	4	26	22	40	28	42	28	24	20	6	4	2	2	NW
W	-4	-4	0	0	6	6	20	12	40	28	48	34	22	22	8	8	2	2	W
NW	-4	-4	0	-2	6	4	12	10	24	20	40	26	34	24	6	4	2	2	SW
N (Shade)	-4	-4	-2	-2	4	4	10	10	14	14	12	12	8	8	4	4	0	0	S (Shade)
4 IN. BRICK OR STONE VENEER + FRAME																			
NE	-2	-4	24	12	20	10	10	6	12	10	14	14	12	12	10	10	6	4	SE
E	2	0	30	14	31	17	14	14	12	12	14	14	12	12	10	8	6	6	E
SE	2	-2	20	10	28	16	26	16	18	14	14	14	12	12	10	8	6	6	NE
S	-4	-4	-2	-2	12	6	24	16	26	18	20	16	12	12	8	8	4	4	N
SW	0	-2	0	-2	2	2	12	8	32	22	36	26	34	24	10	8	6	6	NW
W	0	-2	0	0	4	2	10	8	26	18	40	28	42	28	16	14	6	6	W
NW	-4	-4	-2	-2	2	2	8	6	12	12	30	22	34	24	12	10	6	6	SW
N (Shade)	-4	-4	-2	-2	0	0	6	6	10	10	12	12	12	12	8	8	4	4	S (Shade)
8 IN. HOLLOW TILE OR 8 IN. CINDER BLOCK																			
NE	0	0	0	0	20	10	16	10	10	6	12	10	14	12	12	10	8	8	SE
E	4	2	12	4	24	12	26	14	20	12	12	10	14	12	14	10	10	8	E
SE	2	0	2	0	16	8	20	12	20	14	14	12	14	12	12	10	8	6	NE
S	0	0	0	0	2	0	12	6	24	14	26	16	20	14	12	10	8	6	N
SW	2	0	2	0	2	0	6	4	12	10	26	18	30	20	26	18	8	6	NW
W	4	2	4	2	4	2	6	4	10	8	18	14	30	22	32	22	18	14	W
NW	0	0	0	0	2	0	4	2	8	6	12	10	22	18	30	22	10	8	SW
N (Shade)	-2	-2	-2	-2	-2	2	0	0	6	6	10	10	10	10	10	10	6	6	S (Shade)
8 IN. BRICK OR 12 IN. HOLLOW TILE OR 12 IN. CINDER BLOCK																			
NE	2	2	2	2	10	2	16	8	14	8	10	6	10	8	10	10	10	8	SE
E	8	6	8	6	14	8	18	10	18	10	14	8	14	10	14	10	12	10	E
SE	8	4	6	4	6	4	14	10	18	12	16	12	12	10	12	10	12	10	NE
S	4	2	4	2	4	2	4	2	10	6	16	10	16	12	12	10	10	8	N
SW	8	4	6	4	6	4	8	4	10	6	12	8	20	12	24	16	20	14	NW
W	8	4	6	4	6	6	8	6	10	6	14	8	20	16	24	16	24	16	W
NW	2	2	2	2	2	2	4	2	6	4	8	6	10	8	16	14	18	14	SW
N (Shade)	0	0	0	0	0	0	0	0	2	2	6	6	8	8	8	8	6	6	S (Shade)
12 IN. BRICK																			
NE	8	6	8	6	8	4	8	4	10	4	12	6	12	6	10	6	10	6	SE
E	12	8	12	8	12	8	10	6	12	8	14	10	14	10	14	8	14	8	E
SE	10	6	10	6	10	6	10	6	10	6	12	8	14	10	14	10	12	8	NE
S	8	6	8	6	6	4	6	4	6	4	8	4	10	6	12	8	12	8	N
SW	10	6	10	6	10	6	10	6	10	6	10	8	10	8	12	8	14	10	NW
W	12	8	12	8	12	8	10	6	10	6	10	6	10	6	12	8	16	10	W
NW	8	6	8	6	8	4	8	4	8	4	8	4	8	6	10	6	10	6	SW
N (Shade)	4	4	2	2	2	2	2	2	2	2	2	2	2	2	4	4	6	6	S (Shade)
8 IN. CONCRETE OR STONE OR 6 IN. OR 8 IN. CONCRETE BLOCK																			
NE	4	2	4	0	16	8	14	8	10	6	12	8	12	10	10	8	8	6	SE
E	6	4	14	8	24	12	24	12	18	10	14	10	14	10	12	10	10	8	E
SE	6	2	6	4	16	10	18	12	18	12	14	12	12	10	12	10	10	8	NE
S	2	1	2	1	4	1	12	6	16	12	18	12	14	12	10	8	8	6	N
SW	6	2	4	2	6	2	8	4	14	10	22	16	24	16	22	16	10	8	NW
W	6	4	6	4	6	4	8	6	12	8	20	14	28	18	26	18	14	10	W
NW	4	2	4	0	4	2	4	4	6	6	12	10	20	14	22	16	8	6	SW
N (Shade)	0	0	0	0	0	0	2	2	4	4	6	6	8	8	6	6	4	4	S (Shade)
12 IN. CONCRETE OR STONE																			
NE	6	4	6	2	6	2	14	8	14	8	10	8	10	8	12	10	10	8	SE
E	10	6	8	6	10	6	18	10	18	12	16	10	12	10	14	10	14	10	E
SE	8	4	8	4	6	4	14	8	16	10	16	10	14	10	12	10	12	10	NE
S	6	4	4	2	4	2	4	2	10	6	14	10	16	12	14	10	10	8	N
SW	8	4	8	4	6	4	6	4	8	6	10	8	18	14	20	14	18	12	NW
W	10	6	8	6	8	6	10	6	10	6	12	8	16	10	24	14	22	14	W
NW	6	4	6	2	6	2	6	4	6	4	8	6	10	8	18	12	20	14	SW
N (Shade)	0	0	0	0	0	0	0	0	2	2	4	4	6	6	8	8	6	6	S (Shade)

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Table 2 *(Continued)*

EQUATION: { Total heat transmission from solar transmission and temperature difference between outside and room air Btu per (hr) (sq ft wall area) } = { Temperature differential from above table } × { Heat transmission coefficient for wall Btu per (hr) (sq ft) (F deg) }

NOTES:

1. **SOURCE.** Same as Table 1. A north wall has been assumed to be a wall in the shade; this is practically true. Dark colors on exterior surface of walls have been assumed to absorb 90 percent of solar radiation and reflect 10 percent; white colors absorb 50 percent and reflect 50 percent. This includes some allowance for dust and dirt since clean, fresh white paint normally absorbs only 40 percent of solar radiation.

2. **APPLICATION.** These values may be used for all normal air conditioning estimates, usually without corrections, when the load is calculated for the hottest weather. Correction for latitude (Note 3) is necessary only where extreme accuracy is required. There may be jobs where the indoor room temperature is considerably above or below 80 F or where the outdoor design temperature is considerably above 95 F, in which case it may be desirable to make correction to the temperature differentials shown. The solar intensity on all walls other than east and west varies considerably with time of year.

3. **CORRECTIONS.** *Outdoor minus room temperature.* If the outdoor maximum design temperature minus room temperature is different from the base of 15 F, correct as follows. When the difference is greater (or less) than 15 F add the excess to (or subtract the deficiency from) the above differentials.

Outdoor daily range temperature. If the daily range of temperature is less than 20 F add 1 deg to every 2 deg lower daily range; if the daily range is greater than 20 F, subtract 1 deg for every 2 deg higher daily range. For example, the daily range in Miami, Florida is 12 F, or 8 deg less than 20 F; therefore, the correction is + 4 F.

Color of exterior surface of wall. Use temperature differentials for light walls only where the permanence of the light wall is established by experience. For cream colors use the values for light walls. For medium colors interpolate half way between the dark and light values. Medium colors are medium blue, medium green, bright red, light brown, unpainted wood, natural color concrete, etc. Dark blue, red, brown, green, etc., are considered dark colors.

For latitudes other than 40 deg north; and in other months. These table values will be approximately correct for the east or west wall in any latitude (0 deg to 50 deg North or South) during the hottest weather. In the lower latitudes when the maximum solar altitude is approximately 80 deg to 90 deg (the maximum occurs at noon) the temperature differential for either a south or north wall will be approximately the same as a north, or shade wall. The temperature differential (t_s) for any wall facing, and for any latitude for any month may be approximated as follows:

$$t_s = t_s + \frac{I_2}{I_1} \times (t_w - t_s)$$

where t_s = temperature differential for the same wall in shade for desired time of day; obtained from Table 2.

I_1 = maximum solar radiation intensity transmitted through glass, Btu per (hr) (sq ft) for particular wall facing, in July, 40 deg north latitude (*note:* this is maximum value irrespective of time).

I_2 = same as I_1 except use the maximum value for wall facing, for month, and latitude desired for t_s.

t_w = temperature differential for particular wall facing, for the desired time of day from above table.

Note that this makes adjustment only for solar radiation and that there may be additional correction for outdoor temperature.

4. **FOR INSULATED WALLS** use same temperature differentials as used for uninsulated walls.

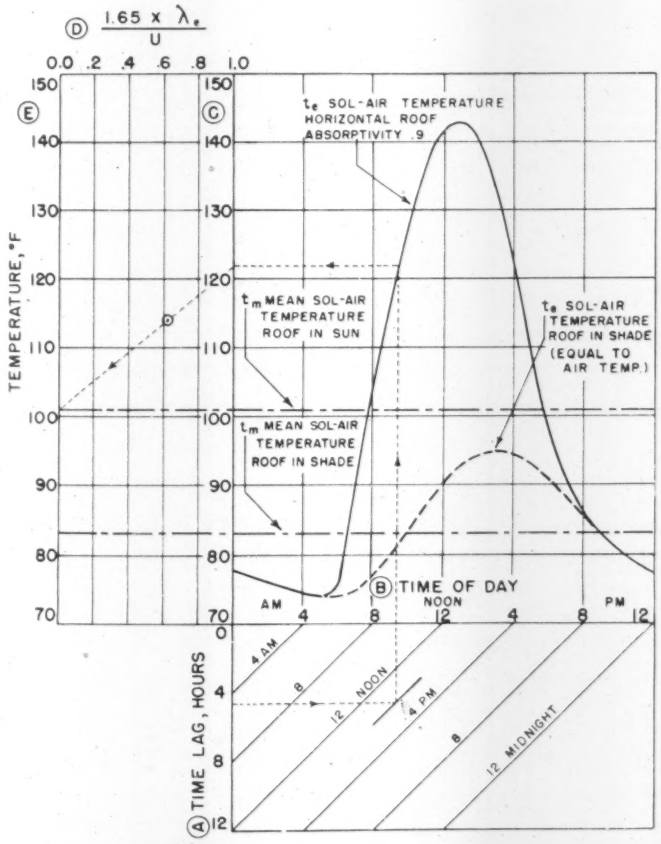


Fig. 2 — Alignment chart for determining temperature differential for roofs

Advantages of Equivalent Differential Method

The use of *equivalent temperature differentials* has several distinct advantages:

1. All wall and roof structures can be covered in a few representative classes listed in Tables 1 and 2, *equivalent temperature differentials.*

2. The total sensible heat flow is easily obtained by multiplying two quantities, one of which is the well known overall heat transmission coefficient, *U* and the other the *equivalent temperature differential* obtainable from Tables 1 and 2. (See *Example 1* in following section and Appendix A).

3. The heat flow rate can be determined easily for other structures not listed in tables, even though the overall heat transmission coefficient is different, provided the structure has thermal and physical properties similar to one of those listed in Tables 1 and 2. A method of determining the homogeneous construction which would be equivalent to the actual composite wall or roof is given in Appendix B.

4. Adjustments can be readily and simply made for room and outdoor con-

ditions different from the basis of the tables. (See *Example 2* in following section). These adjustments are straight-forward and very simple and require no interpolation.

Examples in Use of Equivalent Temperature Tables

Example 1. Given: A roof is constructed of 6 in. stone concrete with 2 in. insulating board and tar felt roofing ⅜ in. thick and is exposed to the sun. Location is central part of United States. Find the rate of heat flow into room at 2:00 P.M. for July for an outdoor design temperature 95 F and room 80 F.

Solution: From Table 1 in 2 P.M. column for 6 in. concrete + 2 in. insulation find the total *equivalent temperature differential* 34 deg. The overall heat transmission coefficient U is taken from Table 3 and is found to be 0.13. The heat flow rate = 34 × 0.13 = 4.42 Btu per (hr) (sq ft).

Example 2. For the conditions of Example 1 find the rate of heat flow into room at 2:00 P.M. for July for an outdoor design temperature of 105 F and a room temperature of 78 F. Daily range of temperature 30 deg, i.e., outdoor temperature 75 F at 4:00 or 5:00 A.M.

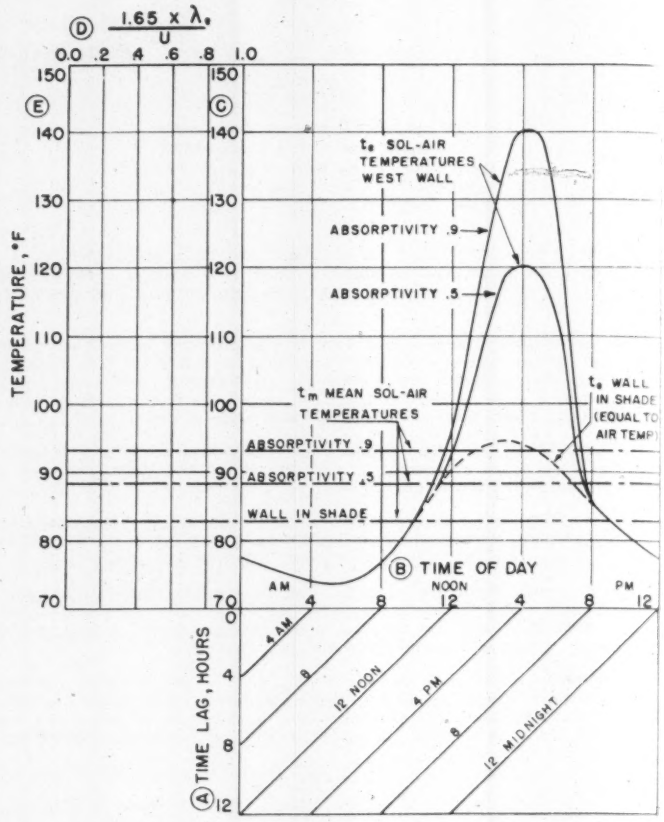


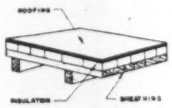
Fig. 3—Alignment chart for determining temperature differential for west walls

Table 3—Coefficients of Transmission U of Flat Roofs Covered With Built-Up Roofing—No Ceiling—Underside of Roof Exposed[a]

Btu per (hour) (square foot) (F deg difference between the air on the two sides)

TYPE OF ROOF DECK	THICKNESS OF ROOF DECK (Inches)	INSULATION ON TOP OF DECK (Covered With Built-Up Roofing)									
		FOR WINTER[c]					FOR SUMMER[c]				
		No Insulation	Insulating Board[e] Thickness, In.				No Insulation	Insulating Board[e] Thickness, In.			
			½	1	1½	2		½	1	1½	2
Flat Metal Roof Deck											
4 Ply Felt Roof		1.06	0.39	0.24	0.18	0.14	0.73	0.35	0.23	0.17	0.13
Ditto + ½ in. Slag		0.64	0.33	0.22	0.16	0.13	0.54	0.30	0.20	0.16	0.13
Precast Cement Tile											
4 Ply Felt Roof	1⅝	0.84	0.37	0.24	0.17	0.14	0.67	0.33	0.22	0.17	0.13
Ditto + ½ in. Slag	1⅝	0.59	0.31	0.21	0.16	0.13	0.50	0.28	0.20	0.15	0.12
Concrete											
4 Ply Felt Roof	2	0.82	0.36	0.24	0.17	0.14	0.65	0.33	0.22	0.16	0.13
	4	0.72	0.34	0.23	0.17	0.13	0.59	0.31	0.21	0.16	0.13
	6	0.65	0.33	0.22	0.16	0.13	0.54	0.30	0.20	0.16	0.13
Ditto	2	0.58	0.31	0.21	0.16	0.13	0.49	0.28	0.20	0.15	0.12
	4	0.53	0.29	0.21	0.16	0.12	0.46	0.27	0.19	0.15	0.12
+ ½ in. Slag	6	0.49	0.28	0.20	0.15	0.12	0.42	0.26	0.19	0.14	0.12
Gypsum and Wood Fiber[b] on ⅜" Gypsum Board											
4 Ply Felt Roof	2⅜	0.40	0.25	0.18	0.14	0.12	0.36	0.23	0.17	0.13	0.12
	3⅜	0.32	0.22	0.16	0.13	0.11	0.29	0.21	0.15	0.12	0.11
Ditto	2⅜	0.33	0.22	0.17	0.13	0.11	0.30	0.20	0.16	0.13	0.11
+ ½ in. Slag	3⅜	0.28	0.20	0.15	0.12	0.10	0.25	0.18	0.14	0.12	0.10

Table 3 *(Continued)*

Wood[d] 	4 Ply Felt Roof	1	0.49	0.28	0.20	0.15	0.12	0.43	0.26	0.19	0.15	0.12
		1½	0.37	0.24	0.17	0.14	0.11	0.33	0.22	0.17	0.13	0.11
		2	0.32	0.22	0.16	0.13	0.11	0.29	0.20	0.16	0.13	0.11
		3	0.23	0.17	0.14	0.11	0.096	0.22	0.16	0.13	0.11	0.094
	Ditto + ½ in. Slag	1	0.39	0.25	0.18	0.14	0.11	0.35	0.23	0.17	0.14	0.11
		1½	0.31	0.22	0.17	0.13	0.10	0.29	0.20	0.15	0.12	0.10
		2	0.28	0.20	0.15	0.12	0.10	0.26	0.19	0.14	0.12	0.10
		3	0.21	0.16	0.13	0.10	0.092	0.20	0.15	0.12	0.10	0.089

[a]See Table 4 for roofs with ceilings.

[b]87½ percent gypsum, 12½ percent wood fiber. Thickness indicated includes ⅜ in. gypsum board. This is a poured roof.

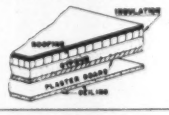
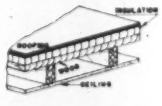
[c]The winter coefficients for a 4 ply felt roof have been taken from the HEATING, VENTILATING AIR CONDITIONING GUIDE, 1948, and were based on an outdoor wind velocity of 15 mph. The summer coefficients are considered temporary and have been calculated with an outdoor wind velocity of 8 mph. For summer an inside surface conductance of 1.2 has been used instead of the regular 1.65 value. In all of these roofs a 4 ply felt roof has been assumed ⅜ in. thick, thermal conductivity k 1.33 from THE GUIDE, 1948. Pitch and slag has been assumed as an additional thickness of ½ in. and has been assigned a value of $k = 1.0$.

[d]Nominal thickness of wood is specified but actual thickness was used in calculations.

[e]If corkboard insulation is used the coefficient U may be decreased 10 percent.

Table 4—Coefficients of Transmission *U* of Flat Roofs Covered With Built-Up Roofing With Lath and Plaster Ceilings[a]

Btu per (hour) (square foot) (Fahrenheit degree difference between the air on the two sides)

TYPE OF ROOF DECK	THICKNESS OF ROOF DECK (Inches)	INSULATION ON TOP OF DECK (Covered With Built-Up Roofing)									
		FOR WINTER[c]					FOR SUMMER[c]				
		No Insulation	Insulating Board[e] Thickness, Inches				No Insulation	Insulating Board[e] Thickness, Inches			
			½	1	1½	2		½	1	1½	2
Flat Metal Roof Deck	4 Ply Felt Roof		0.46	0.27	0.19	0.15	0.12	0.40	0.25	0.18	0.14	0.12
	Ditto + ½ in. Slag		0.37	0.24	0.17	0.14	0.11	0.34	0.22	0.16	0.13	0.11
Precast Cement Tile	4 Ply Felt Roof	1⅝	0.43	0.26	0.19	0.15	0.12	0.38	0.24	0.18	0.14	0.12
	Ditto + ½ in. Slag	1⅝	0.35	0.23	0.17	0.14	0.11	0.32	0.21	0.17	0.13	0.11
Concrete	4 Ply Felt Roof	2	0.42	0.26	0.19	0.14	0.12	0.37	0.24	0.18	0.14	0.12
		4	0.40	0.25	0.18	0.14	0.12	0.36	0.23	0.17	0.13	0.12
		6	0.37	0.24	0.18	0.14	0.11	0.33	0.22	0.17	0.13	0.11
	Ditto + ½ in. Slag	2	0.35	0.23	0.17	0.14	0.11	0.31	0.21	0.16	0.13	0.11
		4	0.33	0.22	0.17	0.13	0.11	0.30	0.21	0.16	0.13	0.11
		6	0.31	0.21	0.17	0.13	0.10	0.29	0.20	0.16	0.13	0.10
Gypsum and Wood Fiber[b] on ⅜ in. Gypsum Board 	4 Ply Felt Roof	2⅜	0.27	0.19	0.15	0.12	0.10	0.25	0.18	0.14	0.12	0.097
		3⅜	0.23	0.17	0.14	0.11	0.097	0.21	0.16	0.13	0.11	0.094
	Ditto + ½ in. Slag	2⅜	0.24	0.17	0.14	0.11	0.095	0.22	0.16	0.13	0.11	0.093
		3⅜	0.21	0.16	0.13	0.10	0.093	0.19	0.15	0.13	0.10	0.090
Wood[d] 	4 Ply Felt Roof	1	0.31	0.21	0.16	0.13	0.11	0.29	0.20	0.15	0.13	0.11
		1½	0.26	0.19	0.15	0.12	0.10	0.24	0.18	0.14	0.12	0.097
		2	0.24	0.17	0.14	0.11	0.097	0.22	0.16	0.13	0.11	0.094
		3	0.18	0.14	0.12	0.10	0.087	0.17	0.13	0.12	0.097	0.085
	Ditto + ½ in. Slag	1	0.28	0.19	0.15	0.12	0.10	0.25	0.18	0.14	0.12	0.10
		1½	0.23	0.17	0.14	0.11	0.095	0.21	0.17	0.13	0.11	0.093
		2	0.21	0.16	0.13	0.10	0.093	0.20	0.15	0.13	0.10	0.090
		3	0.17	0.13	0.11	0.095	0.083	0.16	0.13	0.11	0.093	0.081

[a]See Table 3 for roofs without ceilings.

[b]Calculations based on metal lath and plaster ceilings, but coefficients may be used with sufficient accuracy for gypsum lath or wood lath and plaster ceilings. It is assumed that there is an air space between the under side of the roof deck and the upper side of the ceiling.

[c]87½ percent gypsum, 12½ percent wood fiber. Thickness indicated includes ⅜ in. gypsum board. This is a poured roof.

[d]Notes c, d and e following Table 3 also apply to this table.

Solution: Make correction in *equivalent temperature differential* in accordance with note 5 in Table 1 as follows: The correction for 27 deg design temperature difference is

$$(27 - 15) = +12$$

The correction for 30 deg daily range is

$$\left(-\frac{30-20}{2}\right) = -5$$

Net Total correction is $+12 - 5 = +7$ The heat flow rate at 2:00 P.M. therefore is $(34 + 7) \times 0.13 = 5.32$ Btu per (hr) (sq ft). For method of determining *heat flow rates* when structure is not given in Tables 1 or 2 see *Example 3.*

Example 3. A 4 in. stone concrete roof covered with an average depth of 4 in. cinder concrete on which is placed a ⅜ in. thick felt roof with ½ in. pitch and slag surface is exposed to the sun. The location is in central portion of United States. Design temperatures are: outdoor 95 F; daily range 20 deg; indoor temperature 80 F. Find the heat flow rate at 2:00 P.M. for a day in July.

Solution: For the purpose of selecting the *equivalent temperature differential* this construction is assumed to be equal approximately to an uninsulated 6 in. concrete roof for which the *equivalent temperature differential* is found to be 38 deg in the 2 P.M. column of Table 1. Calculate the overall coefficient U of the roof as follows:

$$U = \frac{1}{\frac{1}{1.2} + \frac{4}{12} + \frac{4}{4.9^*} + \frac{0.375}{1.33} + \frac{0.50}{1.00} + \frac{1}{4.0}}$$

$$= 0.33$$

* k for cinder concrete from Table 2, Chapter 6, The Guide 1948.

The heat flow rate is then $38 \times 0.33 = 12.5$ Btu per hour per square foot.

Conclusions

In the opinion of the author the values in Tables 1, 2, 3 and 4 are as reliable as the other elements used in determination of the cooling load, and they can therefore be used satisfactorily to determine heat flow rates through walls and roofs. Furthermore, adjustments can readily be made in the *equivalent temperature differentials* to compensate for different room or outdoor temperatures. To determine heat flow rates for structures not given in these tables multiply the *equivalent temperature differential* for the structure having the nearest physical and thermal properties by the calculated over-all heat transmission coefficient U.

In view of the large discrepancies between fundamental theory and test results, it is evident that additional experimental research is needed to rationalize theory and practice. It is hoped, therefore, that the Society can continue its valuable program, particularly for roof structures. When more conclusive values of heat transmission through a representative number of structures become known, the tables presented herein for use by the practicing engineer can be revised to reflect the improved accuracy.

Acknowledgments

The writer wishes to thank Prof. C. O. Mackey and Prof. L. T. Wright, Jr. for their advice and valuable suggestions given on several occasions. C. M. Ashley of Carrier Corp. has contributed much in consultation and advice on this project. The writer also wishes to acknowledge the valued assistance of J. F. Schmidt and B. P. Morabito also of Carrier Corp.

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APPENDIX A

Explanation of Method of Computing the Equivalent Temperature Differential

The *equivalent temperature differentials* listed in Tables 1 and 2 were found by the following equation:

$$t_x = (t_b - t_i) \quad \text{(A1)}$$

where

t_x = *equivalent temperature differential*

t_i = indoor temperature (assumed constant at 80 F)

t_b = equivalent outside temperature determined by the equation

$$t_b = t_m + \frac{1.65\lambda_e}{U}(t_e - t_m) \quad \text{(A2)}$$

where

t_m = the daily average sol-air temperature (Fahrenheit degrees)

λ_e = an equivalent decrement factor which includes part of the fundamental and second harmonic decrement factors, dimensionless. It is a function of material characteristics and thickness. (See Appendix B for further explanation)

U = overall heat transmission coefficient of wall or roof, Btu per (sq ft) (hr) (F deg)

t_e = Sol-Air temperature at a time earlier than the time for which heat gain is being found by an amount that is equal to the time lag in heat flow through the wall or roof (Fahrenheit degrees)

Equation A2 may be solved for t_b most conveniently by use of alignment charts such as Figs. 2 and 3. The construction and use of these charts are explained in Appendix C.

Equation A2 was developed by C. M. Ashley from an equation given by Mackey and Wright[4] as explained in Appendix D. In developing Equation A2 however, a slight modification was made in the equivalent decrement factors described in the paper[4] by Mackey

and Wright. Some change was also made in the method[7] of determining the homogeneous structure equivalent to a multi-layer construction. Explanations of these modifications and changes are included in Appendix B.

The thermal conductance $(k/L)_e$ and the value of $(k\rho c)_e$ of the combined structure were calculated for each wall and roof. (For detailed method see Appendix B.) The fundamental time lag was then determined for each structure. The overall heat transmission coefficients were calculated using 4.0 and 1.65 for the outside and inside film coefficients respectively. Next the factors $1.65\lambda_e/U$ were calculated for each wall and roof.

Since the approximate method gives a rather sharp peak in the curve of values for equivalent temperature differentials at the maximum rate of heat flow, the tables were prepared so that *the peaks were rounded off*, reducing the temperature differential due to solar radiation approximately 10 to 15 percent at maximum values only. The temperature differentials for light construction roofs, having very little heat storage capacity were not reduced.

APPENDIX B

Determining Equivalent Homogenous Construction

Very few walls or roofs are of homogeneous construction, consequently, it was necessary to determine the equivalent homogeneous structure. Mackey and Wright define *equivalent homogeneous construction* as a simple homogeneous wall or roof which will have the same variation in indoor surface temperature with time as does the actual composite wall or roof under identical ambient conditions.

The author attempted to determine the equivalent homogeneous construction as outlined by Mackey and Wright in the paper[7], but there was some difficulty in establishing limits for the empirical equations. Professor Mackey suggested the alternate method for determining the equivalent homogeneous construction which is described in the following paragraph. This alternate method was used in calculations.

The fundamental time lag (hours) is first determined for each layer separately by calculating the thermal conductance (k/L) and $k\rho c$, and by using Fig. 2 (showing lag angles, degrees and fundamental time lag in hours) of the Mackey and Wright paper[4]. The sum of the time lags of the layers is then equal to the time lag of the combined wall. The thermal conductance for the combined wall or roof was determined by the relation.

$$\left(\frac{k}{L}\right)_e = \frac{1}{\frac{L_1}{k_1} + \frac{L_2}{k_2} + \frac{L_3}{k_3} + \ldots + \frac{L_n}{k_n}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (B1)$$

where

k = Thermal conductivity, Btu per (hr) (square foot) (Fahrenheit degree per foot of thickness)

L = Thickness of material, feet

c = Specific heat of material, Btu per (pound) (Fahrenheit degree)

ρ = Density of material, pound per (cubic foot)

subscript e = equivalent to a homogeneous material of these characteristics.

Using the combined or equivalent thermal conductance of the structure and the combined time lag, the equivalent $(k\rho c)$ or $(k\rho c)_e$ of the structure is determined from Fig. 2 of the paper[4]. Using $(k/L)_e$ and the $(k\rho c)_e$ the fundamental (first harmonic) decrement factor λ_1 is obtained from Fig. 1 of the paper[4]. The second harmonic decrement factor λ_2, is then obtained from the same Fig. 1 using the same k/L but 2 times $(k\rho c)_e$. The equivalent decrement factor λ_e is determined from

Table B1—Equivalent Decrement Factor

Orientation	λ_e
Horizontal Roof	$0.7\lambda_1 + 0.3\lambda_2$
North Wall	$0.7\lambda_1 + 0.3\lambda_2$
East Wall	$0.2\lambda_1 + 0.8\lambda_2$
South Wall	$0.6\lambda_1 + 0.4\lambda_2$
West Wall	$0.4\lambda_1 + 0.6\lambda_2$

Table B1, which was obtained from a communication of C. O. Mackey to the ASHVE Research Laboratory in 1946. Table B1 is used for both homogeneous and non-homogeneous construction. λ_e refers to the resultant decrement factor when approximating the combined fundamental, second harmonic, etc., decrement factors.

Some inaccuracy is introduced in this method for determining the equivalent homogeneous structure because this method gives the same result no matter whether insulation is placed on the outside layer or on the inside layer of a wall or roof. Assuming the same solar absorptivity, it appears that less heat will flow through a structure if the insulation is placed on the outside. The outer surface temperature will become elevated because of the low heat capacity and low thermal conductivity of the insulation which results in a greater quantity of heat being dissipated to the outdoor air because of a greater difference in temperature.

The equivalent decrement factor λ_e was used to obtain a closer approximation than can be had by merely using the fundamental decrement factor.

APPENDIX C

Construction and Use of the Alignment Charts

The alignment charts shown in Figs. 2 and 3 were constructed from calculations of the sol-air temperature for every hour as shown by Equation 1 of the paper[4]. Nine alignment charts were prepared including one for roofs and one for each of eight different wall facings. The sol-air temperatures were calculated for 0.5 and 0.9 absorptivities for the walls and only 0.9 absorptivity for the roofs. The solar radiation intensity and outdoor air temperature used are explained in Appendix E. The solid lines in Fig. 1 show the values of solar intensity used. Note that the sol-air temperature of a wall or roof in the shade is merely the outdoor air temperature. The dashed lines t_m are the calculated 24 hour average values for each sol-air temperature curve. Scales C and E are the same and separated by the scale D so that any value of $\frac{(1.65\lambda_e)}{U}$ can be readily determined for any corresponding value of t_e and t_m. Scale A is simply a means for subtracting the fundamental time lag in heat flow through the wall from the time of day it is desired to determine the instantaneous rate of heat flow into the room.

Calculation of Temperature Differentials for Tables 1 and 2

Example C1. Given: A roof constructed of 6 in. stone concrete with 2 in. insulating board and tar felt roofing $\frac{3}{8}$ in. thick. Location 40 North Latitude July 23. Room temperature 80 F, outdoor design temperature 95 F, daily range of temperature 20 deg. Find the temperature differential for determining the rate of heat flow into the room at 2:00 P.M. sun time.

Solution: The following thermal and physical properties are determined from Table E2 of Appendix E. Time lag is determined from Fig. 2 of paper[4].

	k/L	$k\rho c$	Time Lag Hours
$\frac{3}{8}$ in. Roofing	3.58	3.1	0.22
2 in. Insulation	0.165	0.116	0.85
6 in. Concrete	2.0	28.0	3.60
Total	—	—	4.67

Determine $\left(\frac{k}{L}\right)_e$ by Equation B1 of Appendix B

$$\left(\frac{k}{L}\right)_e = \frac{1}{\frac{0.375}{1.33} + \frac{2.0}{0.33} + \frac{6}{12}} = 0.147$$

Note that k and L may be expressed here in either inches or feet as long as both are in the same units. From Fig. 2 of paper[4] find $(k\rho c)_e$ corresponding to $\left(\frac{k}{L}\right)_e$ of 0.147 and a time lag of 4.67 hr = 0.55

$2\ (k\rho c)_e = 2 \times 0.55 = 1.1$

From Fig. 1 of paper[4] find λ_1 corresponding to $\left(\frac{k}{L}\right)_e$ of 0.147 and $(k\rho c)_e$ of 0.55 = 0.055.

Also find λ_2 corresponding to $\left(\frac{k}{L}\right)_e$ of 0.147 and $2(k\rho c)_e$ of 1.1 = 0.034.

Using Table B1 of Appendix B determine λ_e.

$$\lambda_e = 0.7\lambda_1 + 0.3\lambda_2$$
$$= 0.7\ (0.055) + 0.3\ (0.034)$$
$$= 0.049$$

Calculate overall heat transmission coefficient U

$$U = \frac{1}{\frac{1}{1.65} + \frac{0.375}{1.33} + \frac{2}{0.33} + \frac{6}{12} + \frac{1}{4.0}}$$
$$= 0.131$$

$$\frac{1.65\lambda_e}{U} = \frac{1.65 \times 0.049}{0.13} = 0.62$$

See Fig. 2. The sol-air temperature at 4.67 hr before 2:00 P.M. (at 9:20 A.M.) is 122 F. The time may be obtained directly by moving horizontally from 4.67 on scale A to 2:00 P.M. on the diagonal scale, then up vertically to the sol-air temperature curve.

The line drawn from scale C to scale E is always from the sol-air temperature on scale C to the mean sol-air temperature corresponding to the sol-air temperature curve.

Draw a line from 122 on scale C to 101 (t_m) on scale E, t_b is 114 F, where this line intersects 0.62 on scale D. The temperature differential therefore is $t_b - t_1$ or (114 — 80) = 34 deg and the instantaneous rate of heat flow at 2:00 P.M. is $(t_b - t_1)\ U = 34 \times 0.13 = 4.42$ Btu per (hr) (sq ft).

The temperature differential at maximum rate of heat flow can be determined in like manner. This value is 47 deg. The value in Table 1 corresponding to this time has been reduced 3 deg as explained in Appendix A.

APPENDIX D

Derivation of Equation A2 Used for Construction of the Alignment Charts Figs. 2 and 3

The following equation was developed by Mackey and Wright[4] to give the approximately correct rate of heat flow in periodic heat flow problems. In this equation t_o is the temperature of the inside surface of the building material. The symbols are the same as those used by Mackey and Wright.

$$(t_o)_{\theta+\frac{\phi_1}{15}} = t_m + \lambda_e[(t_e)_\theta - t_m] \quad \text{.....(D1)}$$

where

$$t_M = t_i + \frac{0.606\ (t_m - t_i)}{0.856 + \frac{L}{k}} \quad \text{.....(D2)}$$

Now

$$U = \frac{1}{\frac{1}{1.65} + \frac{1}{4.0} + \frac{L}{k}} = \frac{1}{0.856 + \frac{L}{k}}$$

therefore

$$t_M = t_i + \frac{U}{1.65}(t_m - t_i)$$

and

$$(t_o)_{\theta+\frac{\phi_1}{15}} = t_i + \frac{U}{1.65}(t_m - t_i) + \lambda_e[(t_e)_\theta - t_m] \quad \text{.....(D3)}$$

Changing Equation D3 to give rate of heat flow $(t_o - t_1) \times 1.65$ by subtracting t_1 and multiplying by 1.65 to both sides.

$$[(t_o)_{\theta+\frac{\phi_1}{15}} - t_i]1.65 = \left\{t_i + \frac{U}{1.65}(t_m - t_i) + \lambda_e[(t_e)_\theta - t_m] - t_i\right\}1.65$$
$$= U(t_m - t_i) + 1.65\lambda_e[(t_e)_\theta - t_m] \quad \text{.(D4)}$$

t_b is defined as the outside air temperature for steady state heat flow through a structure in the shade, which would give the same rate of heat flow as the instantaneous rate of heat flow due to the sol-air temperature at a time earlier by the fundamental time lag in heat flow through the structure.

Therefore from definition of t_b:

$$[(t_b)_{\theta+\frac{\phi_1}{15}} - t_i]U = \text{rate of heat flow to room } \frac{\phi_1}{15} \text{ hours after } \theta$$

Substitute this term in the left side of Equation D4 and divide both sides by U.

$$[(t_b)_{\theta+\frac{\phi_1}{15}} - t_i] = t_m - t_i + \frac{1.65\lambda_e}{U}[(t_e)_\theta - t_m] \quad \text{.....(D5)}$$

Cancel t_i in both sides

$$(t_b)_{\theta+\frac{\phi_1}{15}} = t_m + \frac{1.65\lambda_e}{U}[(t_e)_\theta - t_m] \quad \text{.....(D6)}$$

Then

$$t_b = t_m + \frac{1.65\lambda_e}{U}(t'_e - t_m)$$

where

t'_e = sol-air temperature taken at an earlier time, equal to the fundamental time lag in heat flow through the structure when calculating the instantaneous rate of heat flow to the room.

APPENDIX E

Explanation of Constants and Variables Used in Calculations

Heat Transfer Film Coefficients—The outside surface heat transfer coefficient of 4.0 Btu per (sq ft) hr (F deg temperature difference) was used. It corresponds to an average wind velocity of approximately 7 mph. The inside surface heat transfer coefficient of 1.65 was used. These are the same general values selected by Mackey and Wright.

Solar Radiation—The actual values of solar radiation used in the calculations are shown in Fig. 1. (Also see section on Special Consideration for Roofs.) The design values are for July 23, 40 deg North Latitude. Fig. 1 also gives the design values recommended in THE GUIDE, 1948. When Tables 1 and 2 were prepared, THE GUIDE 1946 did not show sky or diffuse radiation through windows and therefore sky radiation is not included in these calculations. The inclusion of sky radiation would increase the rates of heat flow slightly. The data in THE GUIDE 1948 do not fully reflect the absorption of solar radiation by the atmosphere under design conditions in summer, the effect of which would be to lower design values of solar radiation.

Absorptivity to Solar Radiation—The absorptivity of very light colors such as white or cream is based on 0.5. Most white paints have an absorptivity as low as 0.4 but it is believed that there will usually be sufficient dust and soot to increase this value to 0.5. Medium colors such as medium grey, blue, green, pink, etc., are based on 0.7 absorptivity. Dark colors were based on an absorptivity of 0.9. Calculations were made only for the light and dark walls. A straight line interpolation between these values is required to obtain the temperature differential for medium color walls.

Heat flow through roofs was calculated only for an absorptivity of 0.9 because it is believed that a light colored roof soon becomes dark due to collection of soot and dirt. It is not practicable to paint a light colored roof

Table E1—Absorptivity[a] of Materials to Radiation

Material	Absorptivity for Solar Radiation	Absorptivity for Low Temp. Radiation at Approx. 100 F
Aluminum Foil....	0.39	0.05
Aluminum Paint...	0.63	0.3 - 0.6
Brick, Cream.....	0.39	—
Red	0.70	0.93
Blue	0.88	—
Concrete Tiles,		
Uncolored	0.67	0.90
Brown	0.87	0.90
Black	0.92	0.90
Galvanized Iron,		
Bright	0.77	0.23
Lampblack	0.96	—
Paint, Flat White..	0.35	0.90
Glossy White.....	0.30	0.90
Silver Gray.....	0.53	0.90
Slate	0.71	0.90
Medium Green...	0.94	0.90
Paper, White.....	0.35	0.94
Plywood, New.....	0.60	—

[a]These values are only approximate.

Table E2—Physical and Thermal Properties of Materials Used in Calculations

Material	ρ Density Lb/(Cu Ft)	k[a] Thermal Conductivity Btu/(Hr) (Sq Ft) (F Deg)		c Specific Heat Btu/(Lb) (F Deg)
		Ft Thick.	In Thick.	
Brick, Common	112	0.42	5.0	0.20
Brick, Face	125	0.77	9.2	0.22
Concrete, Stone	140	1.00	12.0	0.20
Gypsum Plank	78	0.24	3.0	0.26
Insulating Board	13	0.028	0.33	0.32
Plaster, Metal Lath	90	0.27	3.30	0.20
Plaster, on Masonry	100	0.42	5.00	0.20
Rock Wool	5.7	0.025	0.30	0.20
Roofing, Felt	70	0.11	1.33	0.40
Slag (on Roof)	55	0.83	1.00	0.40
Tile, Hollow Clay 8 in.	70	0.42	5.0	0.22
Tile, Hollow Clay 12 in.	70	0.42	5.0	0.22
Wood	37	0.066	0.80	0.60
Air Space[b]	—	—	—	—

[a] In calculations of $k\rho c$, etc., k is in feet thickness.
[b] k/L of an air space = 1.1 but $k\rho c = 0$.

often enough to maintain the light color. There may be certain locations in the Tropics where there is no smoke from industrial activity or from heating plants where it would be practicable to maintain the light color. See Table E1 for values of solar absorptivity selected from several sources. More reliable data on solar absorptivity would be desirable.

Design Air Temperatures—The room temperature was assumed constant at 80 F. The outdoor design dry bulb temperature was 95 F at peak, occurring about 3:00 P.M. and lowest temperature of 73.5 F occurring at 5:00 A.M. This is a daily range of dry bulb temperature of 95 — 73.5 equals 21.5 deg or say 20 deg daily range for round figures. These outdoor air temperatures were selected as being typical of the climate representative of the large central area of the United States. This daily range is also typical of the larger central area. The daily range is much lower near any large body of water, as at the seashore, where it may be 12 to 14 deg. In semi-arid regions and at high elevations, the daily range may be 30 to 35 deg. (For method of adjusting of other daily ranges, see notes following Tables 1 and 2.)

Physical and Thermal Properties of Materials—See Table E2 for values used in calculations.

Special Consideration for Roofs—Because of the large discrepancy between the experimental and calculated values of heat gain to roofs due to solar radiation and because of a suspicion that the regular overall heat transmission coefficients are too high, it was decided to reduce the solar radiation effect received by the roof by 20 percent. This can be considered as an arbitrary change, which for example, would be equivalent to a change in wind velocity from 7 to 10 mph. The sol-air temperatures shown on the alignment chart Fig. 2 reflect this 20 percent reduction. A study of the tests [5, 6] shows thermal conductivities for felt roofing and concrete which are lower than the accepted values.

Roofs Sprinkled and Flooded with Water—Because of the extra complication, and the low rate of heat gain involved with sprinkled or flooded roofs, no attempt has been made to calculate the heat transmission. Instead, the temperature differentials have been set up on a judgment basis using the tests,[5, 6] and modified for higher outdoor wet bulb temperatures which occur in some sections.

Constant Indoor Air Temperatures—The assumption is made that the room will be cooled 24 hours per day, but this is true only in such applications as hotels, apartments, etc., except in extremely hot weather, when operators find it desirable to operate the cooling system 24 hours per day to take advantage of storage. For intermittent operation, the rates of heat flow theoretically should be greater, but it is not known how much greater. Values in Tables 1 and 2 are thought to be safe for intermittent operation occuring during one 8 or 10 hour period of operation in 24 hours.

Discussion

H. B. NOTTAGE, Cleveland, Ohio (WRITTEN): The tabulated *equivalent temperature differentials* may be employed directly to expedite the method of cooling-load analysis presented in THE GUIDE 1948. The developments in both THE GUIDE and in this paper represent an immediate practical treatment of a problem on which there has been considerable discussion in the Technical Advisory Committee on Cooling Load. As Mr. Stewart has pointed out, this treatment is not to be blindly accepted as the ultimate and only method. The great need in the near future is for a widespread accumulation of practical experience which will enable decisions to be made regarding whatever further work may be justified.

It also seems well to introduce into the record, on behalf of the Technical Advisory Committee on Cooling Load, a brief comment on the exact mathematical solution for structural sections comprising several layers of different materials. The TRANSACTIONS' version of the paper by Mackey and Wright[1] presents complete solutions for two-layer and three-layer walls. Since the algebraic expressions as presented therein are somewhat cumbersome, further manipulation was undertaken at the ASHVE Research Laboratory to find out if simplification were possible. In doing this the many variables involved were reduced by combination into *characteristic dimensionless groups*. Both of the surface conductances were treated as unspecified variables in this treatment. The results were as follows:

No. of Layers	1	2	3	n
No. of Characteristic Dimensional Groups	3	5	7	2n+1

When it is realized, for example, that any general presentation of the behavior of a five-layer wall would require a series of curves or tabulations embracing eleven variables, then the justification for rough approximations becomes further evident. Professor H. A. Johnson has presented the complete picture for a single layer wall[2], and this will further show how extensive the general problem can become.

It should be mentioned that complete mathematical solutions for walls of more than three layers have been carried out[3,4] and can be referred to by anyone specially interested, but so far no one has undertaken to reduce these analyses to simple arithmetic manipulations for rapid use.

Finally, there are still unanswered questions regarding periodic heat flow in two- or three-dimensional temperature fields, such as occur in corners, through hollow building tiles or concrete blocks, at wall junctures, and the like. Also, the assumption of neglible thermal capacitance for air spaces is seemingly justifiable for the periods and amplitudes encountered in air conditioning, but not necessarily so for other systems.

[1] ASHVE RESEARCH REPORT No. 1299—Periodic Heat Flow—Composite Walls or Roofs, by C. O. Mackey and L. T. Wright, Jr. (ASHVE TRANSACTIONS, Vol. 52, 1946, p. 283.)

[2] Periodic Heat Transfer at the Inner Surface of a Homogeneous Wall, by H. A. Johnson. (ASHVE JOURNAL SECTION, *Heating, Piping & Air Conditioning*, Vol. 20, No. 5, May, 1938.)

[3] Operational Solution of Some Problems in Heat Transfer, by A. U. Bryant. (M. S. Thesis, University of California, 1940.)

[4] Om Anvendelse af Operator—Regning paa Varmetransmissionslaeren, by F. C. Becker, Meddelelse I-V fra Danmark's Tekniske Hoejskole's Laboratorium for Opvarmning og Ventilation, Copenhagen, 1945, p. 76-86. (To be translated and published in English during 1948.)

W. E. Zieber, York, Pa. (Written): This paper is a valuable contribution to the periodic heat flow work which has been carried on by your Technical Advisory Committee on Cooling Load, of which the author is a member. Preparation of this paper was urged by the committee after the ASHVE Research Laboratory checked these tables for the committee.

Mr. Nottage of the Laboratory staff has been correlating the work for the committee and during his effort to obtain a method of presenting the tables embodying Mackey & Wright's work, he discovered that Mr. Stewart was working on tables of this type. He checked Mr. Stewart's work and felt that his method might be off a little on the time basis, that is; there might be an hour's time discrepancy in the peak heat load. The committee considered this close enough for practice, considering today's knowledge of the subject.

There would be considerable work necessary to prove by practical tests this mathematical work by Mackey and Wright and the adjusted tables by Mr. Stewart.

Interest in this subject is lacking because periodic heat flow is a small portion of the cooling load and, consequently, an error in it would not affect cooling load excessively. The more radical case would be a roof of light construction on a one-story building, without water covering of the roof or a spray pond on the roof.

The committee would like to have any engineering suggestions regarding this work at a very early date so that they could be considered before these tables are submitted for use in The Guide.

After several years practice with these tables, if they prove sufficiently inaccurate, we may be able to arouse enough interest to justify the expense of tests. Right now there appear to be more weighty problems on which to spend money.

I again wish to thank Mr. Stewart and his colleagues in the name of the Cooling Load Committee for this contribution.

C. O. Mackey, Ithaca, N. Y. (Written): The concept of equivalent temperature differential and the many tables prepared by Mr. Stewart give a convenient method of estimating rate of gain of heat through roofs and walls due to the combined effects of solar radiation and temperature difference. Mr. Stewart made an arbitrary reduction in sol-air temperatures for roofs by assuming that the product of solar radiation incident upon horizontal roofs and absorptivity divided by film coefficient was 80 percent of the value calculated from Fig. 1 for any time of day when using an absorptivity of 0.9 and a film coefficient of 4 Btu per (hr) (sq ft) (F deg).

This is undoubtedly a step in the right direction if the tables are to be used in estimating cooling loads. There are many reasons why this procedure may be justified; nocturnal radiation lowers the daily average sol-air temperature and reduces the rate of heat gain at any hour of the day; the film coefficient of heat transfer from horizontal surfaces to outdoor air is generally greater than from vertical surfaces to air. The most important consideration, however, is that instantaneous rates of gain of heat from the room surfaces of roofs and walls *are not cooling loads*. Roughly two-thirds of this instantaneous rate of heat gain is in the form of radiation; this heat gain is not felt as cooling load until (1) the radiant energy is absorbed by other room surfaces such as floors and partitions, (2) the building materials absorbing this radiation are warmed to a temperature above that of the room air, (3) the heat is transferred from these surfaces to indoor air. Due to the storage of heat in the building materials, the maximum cooling load will not be as great as the maximum instantaneous rate of heat gain and will occur at a later time.

In general, if any engineer is interested in the accurate estimate of cooling load, he must differentiate between cooling load and instantaneous rate of heat gain. The difference is particularly important when (1) the instantaneous rate of heat gain fluctuates appreciably with time, (2) the building materials have high heat capacity, (3) any appreciable portion of the instantaneous rate of heat gain is in the form of radiant energy. These remarks apply with equal force to solar radiation transmitted by glass and to internal loads resulting from heat emitted by appliances, lights, and people. It may be very inaccurate to conclude because one square foot of west glass, for example, transfers heat to indoor air and room surfaces at the rate of 208 Btu per hr at 4 p.m., that the cooling load is increased by this amount at this time. Specific examples of lighting loads that illustrate this principle appear in Mr. Leopold's paper.

C. S. Leopold, Philadelphia, Pa. (Written): I should like to know if you have differentiated between the thermal release of the inside of the exposed surface and the thermal gain of the air-water mixture, which would represent the cooling load at any given time. Most of the thermal release is by radiation. Radiation does not result in appreciable increase of the temperature of the air and water vapor until it has caused a temperature rise and, in turn, resulted in convection. In warming the surface of the solid, an important portion of the heat may be conducted into the solid, or even out of the immediate system, thus not effecting a corresponding increase in air temperature.

G. V. Parmelee, Cleveland, Ohio (Written): Mr. Stewart has in this paper presented, in tabular form, data which are to be used with the quite familiar value of U for walls or roofs. The form in which these data appear will undoubtedly be well received by the practicing engineer. The equivalent temperature differentials shown have been derived in part from approximate rational equations developed by Prof. Mackey from test data obtained by the ASHVE Research Laboratory some years ago in Pittsburgh and from data from many other sources. They therefore represent a great deal of very patient effort.

In following through certain rather basic assumptions, several points need clarification.

1. It is recommended that overall coefficients for summer be used. Tabular values using an inside surface conductance of 1.2 are presented. However, the expression which defines the equivalent outside temperature takes 1.65 as the indoor surface conductance. Use of 1.2 instead of 1.65 would lower significantly the equivalent outside temperature.

2. Because of a discrepancy between experimental and calculated values of heat gain through roofs due to solar irradiation, the solar radiation effect was reduced 20 percent to bring the computed values more in harmony with the lower experimental values. However, the agreement between experimental and calculated values for walls was reasonably good. It is not clear why this adjustment is justified, since uncertainties as to test data accuracy must apply with equal emphasis to both walls and roofs.

3. The reasoning behind the adjustment for daily range in temperature is not clear. One suspects that, where the daily range is greater than average, the solar intensity is also greater. Except where air drainage into valleys is to be considered, the daily range is probably roughly inversely proportional to the clearness of the atmosphere and hence, roughly, directly proportional to the solar intensity. Therefore, the adjustment for daily range is probably balanced by a greater solar intensity.

Mr. Stewart's paper points up the need for better fundamental data, particularly with regard to the heat transfers and exchanges that take place at the interior and exterior boundary surfaces of buildings. In addition, thermal storage of the building structure must be considered relative to instantaneous cooling load. Is it not time for the Society to consider undertaking carefully instrumented and controlled full-scale studies of cooling and heating loads and the influence of both internal and external factors? The problem is within the scope of several technical advisory committees and is deserving of activation in the very near future.

I would like to ask Mr. Stewart how much difference there is between the theoretical and test values for heat flow through walls and roofs.

Semi-Annual Meeting

Bretton Woods, N. H.

G. L. Tuve—*President*
Cleveland, Ohio

THE Society's Semi-Annual Meeting 1948 was held in the scenic White Mountains, June 20-23, 1948, where 340 members, ladies, and guests attended the sessions at the Mount Washington Hotel, Bretton Woods, N. H.

The majority came by car, in order to enjoy the scenic beauty en route, and the honors for long distance driving go to Prof. F. W. Hutchinson, who drove from Berkeley, Calif. Members and guests came from 26 states of the United States and from Canada, England, and South Africa.

The three technical sessions were well attended and all of the papers produced some interesting discussions.

First Session—Monday, June 21, 10:00 a.m.

Pres. G. L. Tuve, Cleveland, Ohio, called the Semi-Annual Meeting 1948 to order at 10:00 a.m., in the Mount Washington Hotel, and C. M. F. Peterson, Boston, chairman of the Committee on Arrangements, gave a short welcoming address to which President Tuve responded.

Announcement of the appointment of the Resolutions Committee was made by President Tuve as follows: I. W. Cotton, Indianapolis, Ind., chairman; C. M. Burnam, Jr., Chicago, Ill., and A. J. Hess, Los Angeles, Calif.

President Tuve then announced that the first matter of business would be consideration of the Amendment to the By-Laws, and requested the secretary to read the amended Article IV, *Section 2*, of the By-Laws as follows:

Article B-IV—Admission Fees and Dues

Section 2. The annual dues of Members and Associate Members shall be twenty-five dollars ($25.00); of Junior Members ten dollars ($10.00); of Student Members three dollars ($3.00).

R. A. Sherman, Columbus, Ohio, chairman of the Finance Committee, briefly reviewed the reasons for proposing a change in the dues rate for Members and Associate Members. Speaking for the Finance Committee, he stated that it had struggled with the budget at two long meetings since the Annual Meeting in February and had presented a revised budget to the Council at its April 19 meeting. A very small surplus had been indicated and if all estimates were accurate it might be possible to get by, but any lag in membership growth or in publication activities might change the picture rapidly.

The Council on April 19, had thoroughly explored and discussed the matter and had reluctantly accepted the committee's conclusion that it would be better to return to the old rate of dues which prevailed in the pre-depression days, rather than adopt some of the other alternatives that were open.

Although the proposed increase in dues is an increase of 39 percent, the increased income to the Society based on our present number of Members and Associate Members would bring an increased income of about $34,000 to the Society, of which only about $20,000 would go to general Society activity. Thus, the increase to the income as now estimated in our present operating budget would be only of the order of 10 percent.

It was a fact that the proposed increase from $18.00 to $25.00 was substantial but the division of 60 percent for general Society functions and 40 percent for research, provided an additional $4.20 for general Society activities and $2.80 for research. Mr. Sherman reviewed the sources of Society income, and stated that the Council had discussed the desirability of maintaining present services all in one package, and had also considered charging for some of the present services.

In looking for a method of solving the financial problem serious consideration was given to reducing some services or for example, making an additional charge for THE GUIDE and TRANSACTIONS.

After studying the experiences of other organizations, it was evident to the Committee and to the Council that the Society could not be operated on a depression dues rate,

and omitting any of the present services or making an extra charge would take away some of the rights and privileges of membership and probably would cause dissatisfaction.

The question also came up as to the timeliness of introducing the question of a dues increase and it was found that in order to have it take effect for 1949, it was necessary to present the Amendment to this Semi-Annual Meeting, rather than delay it for vote at the Annual Meeting in Chicago next January.

DUES INCREASE APPROVED

With this explanation, it was *moved* by Mr. Sherman, *seconded* by C. F. Boester, Lafayette, Ind., that the following Amendment to Article B-IV, *Section 2* be adopted as follows:

Section 2. The annual dues of Members and Associate Members shall be twenty-five dollars ($25.00); of Junior Members ten dollars ($10.00); of Student Members three dollars ($3.00).

President Tuve asked for discussion of the question and stated that an invitation had been extended to all present to have an informal discussion of the dues question on the previous evening, but no one had attended. He called a second time for comments and discussion and when the question was called for, the vote was unanimously in favor of the adoption of the Amendment, and President Tuve indicated that it would be effective for the year 1949.

The secretary then presented the Amendments to the Proposed Regulations Governing Committee on Research, which have been suggested by the Finance Committee in order to simplify financial operations affecting research activities.

ARTICLE III—DUTIES OF OFFICERS

Section 3. Director of Research—The Director of Research shall be responsible to the Committee on Research. He shall supervise all Laboratory activities of the Society and shall have general charge of all research activities including the making of contracts for the rental or purchase of equipment or materials. He shall, under the authority of the Committee, select and engage, when necessary, a supervisor of the Research Laboratory and such research assistants and other personnel as may be required.

The Director of Research shall, subject to the approval of the Research Executive Committee, determine the order in which the subjects shall be investigated by the Research Laboratory.

The Director of Research shall prepare, for the Research Executive Committee, a budget of estimated income and expenditures of the Committee on Research for the next fiscal year.

All bills against Research which are covered by the budget shall, before being presented to the Secretary of the Society for payment, be approved by the Director of Research.

AMEND PARAGRAPH 3 OF *SECTION 3* TO READ AS FOLLOWS:

The Director of Research shall prepare, for the Research Executive Committee, a budget of estimated income and expenditures of the Committee on Research for the next fiscal year for submission to and approval by the Council.

OMIT PARAGRAPH 4 OF *SECTION 3* AS FOLLOWS:

All bills against Research which are covered by the budget shall, before being presented to the Secretary of the Society for payment, be approved by the Director of Research.

ARTICLE IV—DUTIES OF COMMITTEES

Section 2. Research Executive Committee—(*b*) The Research Executive Committee shall before November first of each year adopt a budget of estimated income and expenditures of the Committee on Research for the next fiscal year. Any proposed expenditure of Research funds outside of the approved budget shall be approved by the Executive Committee or, by delegation, by the Chairman of the Committee on Research, before the expenditure is made.

TO BE AMENDED AS FOLLOWS:

Section 2. Research Executive Committee—(*b*) The Research Executive Committee shall, before October first of each year, prepare a budget of estimated income and expenditures for research operations for the next fiscal year and submit it for approval to the Committee on Research and then to the Finance Committee and Council for approval at its Fall Meeting.

ARTICLE V—GOVERNMENT

Section 7. Payment of Bills—(*a*) All bills against Research activities shall be approved by the Director of Research, and he shall present approved bills to the Secretary of the Society. The Secretary shall check and, if correct, pay all items when covered by the budget or emergency expenditures approved in writing by the Chairman of the Committee on Research. A summary of these accounts shall be made at least every month on a form approved by the Council. The Treasurer of the Society shall issue a check against the Research Fund, payable to the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, which check shall be deposited in the Secretary's Special Account. The Secretary shall draw against this amount in settlement of all approved expenditures.

(*b*) The Secretary shall have the authority to pay salaries, traveling expenses and petty cash in accordance with the budget.

(*c*) The depository for current Research funds shall be selected by the Research Executive Committee, subject to the approval of the Council.

TO BE AMENDED AS FOLLOWS:

Section 7. Payment of Bills—(*a*) The Director of Research shall receive and shall check all bills against the research activities of the Society. If correct, he shall approve and pay all items when covered by the budget or additional expenditures approved by the Council. A summary of the accounts paid by the Director of Research shall be made at least every month on a form approved by Council and copies shall be submitted for approval to the Chairman of the Committee on Research, who shall forward copies to the Secretary, the President, and the Treasurer. On their approval, the Treasurer of the Society shall transfer funds from the Treasurer's Account for deposit to the credit of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS in the Director's Account. The Director of Research shall draw against this account in settlement of approved expenditures only.

(*b*) The Director of Research shall have the authority to pay salaries, traveling expenses and petty cash in accordance with the Budget.

(*c*) The Director's Account shall be kept in a depository selected by the Research Executive Committee, subject to the approval of the Council.

ARTICLE V—GOVERNMENT

Section 8. Accounts—The books of accounts shall be kept at the headquarters of the Society, and shall be audited each year at the time the Society books are audited and by the same certified public accountant, who examines the Society accounts. The accountant's report shall be presented at the Annual Meeting of the Society by the Chairman of the Committee on Research as the financial report on research activities for the year.

TO BE AMENDED AS FOLLOWS:

Section 8. Accounts—The books of accounts shall be kept at the Research Laboratory, and shall be audited each

year at the same time and by the same certified public accountant, as the other Society Accounts. The accountant's report shall be presented at the Annual Meeting of the Society by the Chairman of the Finance Committee as the financial report on research activities for the year.

President Tuve asked for discussion of the Amendments and none was offered and he inquired of L. N. Hunter, chairman of the Committee on Research, whether he had any comments.

RESEARCH REGULATIONS REVISED

On motion of H. E. Parker, Boston, Mass., properly seconded, it was voted:

THAT action be taken on the Amendments as a whole.

It was moved by M. W. Bishop, Chicago, Ill., seconded by C. F. Boester,

THAT the Proposed Amendments to the Regulations Governing the Committee on Research, **Article III,** *Section 3,* **Article IV,** *Section 2,* **Article V,** *Sections 7* and *8* be adopted.

When the vote was called for, this motion was unanimously passed.

EVALUATING CLOTHING INSULATION

President Tuve introduced Cyril Tasker, director of research of the ASHVE, Cleveland, Ohio, to present the paper on **Thermal Insulation of Clothing,** by C. P. Yaglou (complete paper and discussions to be published in the September JOURNAL SECTION, *Heating, Piping & Air Conditioning*). Mr. Tasker gave a summary of the paper which described two principal methods of evaluating clothing insulation.

Written discussions were contributed by the following: H. C. Bazett, professor of physiology, University of Pennsylvania School of Medicine, Philadelphia, Pa.; K. E. Bell, vice president, A. C. Lawrence Leather Co., Peabody, Mass.; A. C. Burton, professor of biophysics, University of Western Ontario, London, Ont., Canada; A. P. Gagge, Lt. Colonel, MSC, Aero Medical Laboratory, Dayton, Ohio; A. C. Goodings, director of textile research, Ontario Research Foundation, Toronto, Ont., Canada; Dr. Milton Harris, Harris Research Laboratory, Washington, D. C.; L. H. Newburgh, M.D., Ann Arbor, Mich.; H. B. Nottage, research associate, ASHVE Research Laboratory, Cleveland, Ohio; Sid Robinson, professor of physiology, Indiana University, Bloomington, Ind.; Dr. R. A. Siple, General Staff, U. S. Army; and Dr. C.-E. A. Winslow, Yale University School of Medicine, New Haven, Conn.

The comments of the author in reply to the written discussions were presented by Mr. Tasker.

Discussions were invited from the floor by President Tuve.

DEAN L. E. SEELEY, University of New Hampshire, Durham, N. H., pointed out an important matter was the use of a flannel band around the middle of a soldier.

FRED JOHNSON, Detroit, Mich., felt that some of the problems of heating and comfort would be solved by having more data which would give useful information on men's and women's clothing.

NATHANIEL GLICKMAN, Chicago, Ill., called attention to a typographical error and said that two critical areas of the body were the bend of the elbow and the knee cap.

DR. THOMAS BEDFORD, London, England, felt that further improvement of research techniques would bring better data.

MT. WASHINGTON WEATHER

President Tuve introduced E. H. Stolworthy, associate professor of mechanical engineering, University of New Hampshire, Durham, N. H., who presented the paper by Prof. D. H. Chapman, on **The Mount Washington Observatory** (published in the JOURNAL SECTION, *Heating, Piping & Air Conditioning*, July 1948). In his presentation Professor Stolworthy gave some history of the Mount Washington Observatory and a summary of the experimental work being carried on. He showed some interesting slides which had been made during the various stages of the work. (At a special showing some technicolor films of the operations of the Mount Washington Observatory were shown by Professor Stolworthy to both the members and ladies who attended the meeting.)

JOURNAL SECTION

WINTER AND SUMMER ADJUSTMENTS

President Tuve then introduced Nathaniel Glickman, assistant professor of medicine and research physiologist, Department of Medicine, University of Illinois, Chicago, Ill., who presented his paper, **Comparison of Physiological Adjustments of Human Beings During Summer and Winter** (see page 113 this issue). Professor Glickman gave a summary of the paper and stated that the tests described are studies on the rapidity and magnitude of physiological adjustments made by the body, at rest, on exposure to sudden changes of environmental temperature and humidity during the winter months. Comparisons are made with similar tests conducted in summer. He explained that four healthy male medical students ranging in age from 19 to 23 years were used as subjects, three being the same who were used in summer tests.

Professor Glickman told that after one hour exposure to a *comfortable* environment, reactions were the same in summer and winter, and that the comfort impression on entering a *comfortable* room was higher in winter than in summer. He also explained that after one hour in the hot room, mean skin temperature was the same in winter and summer, but rectal temperature increased slightly more in winter. He further stated that perspiration was greater in summer although the time of appearance on the subject was the same.

President Tuve then called for discussion and one written discussion was presented by Dr. Bedford.

DR. THOMAS BEDFORD, D.Sc., Ph.D., London, England (WRITTEN): I am glad to have had an opportunity of seeing this interesting paper. The experiments on which it is based are not numerous, but the results have been subjected to careful statistical examination and there seems to be no doubt about the conclusions. I have been somewhat surprised that little or no evidence of seasonal adaptation was found, for I think it likely that with British subjects some such adaptation would have been noticed. Certainly, observations on

working subjects in Great Britain have shown seasonal differences. Thus, Vernon and Warner (*Journal Hygiene*, Camb., Vol. 32, p. 431, 1932) found that subjects performing the same tasks at the same effective temperature had higher pulse-rates in winter than in summer.

L. T. AVERY, Cleveland, Ohio, stated that it is desirable to have engineering and medical collaboration and he further stated that the results of operating a plant on a 24-hour basis at 69 deg ET provided an agreeable atmosphere for everyone and that there were no complaints from either men or women on the constant conditions that were maintained, although the work in the different departments varied considerably.

MR. TASKER then referred the members to a paper published in the April 1948 issue of the *Journal of the Institution of Heating and Ventilating Engineers* on Comfort Cooling in the Tropics, by J. F. L. Grocott, which describes the operation of an air conditioning plant in the tropics and reports the observations for a ten-year period.

PROFESSOR GLICKMAN stated that the subjects attired in cotton union suits could not be compared very readily with a man wearing a heavy woolen suit, and he felt that a 65 deg temperature would not be comfortable for them.

President Tuve read a wire from Prof. W. F. Wells, associate professor of air-borne infection, University of Pennsylvania, Philadelphia, Pa., who regretted his inability to attend the meeting and stated that his paper on the **Sanitary Significance of Ventilation** (to be published in the JOURNAL SECTION, *Heating, Piping & Air Conditioning*) would not be presented in detail, but copies of the paper were available and those interested in the subject could present their comments which would be forwarded to the author.

The meeting adjourned at 12:15 p.m.

FLOOR PANEL GROUND LOSSES

Second Technical Session, Tuesday, June 22, 9:30 a.m.

Pres. G. L. Tuve called the second technical session to order at 9:30 a. m. and requested Vice Pres. A. E. Stacey, Jr., Syracuse, N. Y. to take charge of the meeting. Mr. Stacey introduced Prof. A. B. Algren, Minneapolis, Minn., who presented his paper, **Ground Temperature Distribution with a Floor Panel Heating System,** (published in the May 1948 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

P. B. GORDON, New York, N. Y. (WRITTEN): Professor Algren's paper shows how serious the ground loss might become in the operation of a floor panel heating system. It shows the need for proper insulation to reduce these losses which may become too large for proper economy. It also draws attention to those under-designed systems that require higher operating temperature levels for the proper heating of the occupied areas but with resulting higher percentage losses to the ground.

Of further interest would be information on the increase in this percentage loss to the ground during a period of increasing load caused by sudden drop in outside weather conditions after a long period of equilibrium. This increase in percentage loss to the ground during such a condition would be of interest in its effect on boiler or heater capacity for this type of system.

Verbal discussions were given by Cyril Tasker, Cleveland, Ohio; Vic Sanders and R. A. Miller, Pittsburgh, Pa.; Pres. G. L. Tuve, Cleveland; and H. D. Bratt, Grand Rapids, Mich.

EXPERIMENTAL RESEARCH NEEDED

Since neither of the authors of the next paper could be present, an abstract of the paper, **Theory of the Ground Pipe Heat Source for the Heat Pump,** by L. R. Ingersoll and H. J. Plass, was presented by Carl H. Flink. (published in the July 1948 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

C. M. ASHLEY, Syracuse, N. Y. (WRITTEN): In practice it is necessary to use a whole gridwork of coils instead of the single coil or loop discussed in this paper.

As a result the surrounding assumptions are completely changed. In addition most of the heat extracted must, of economical necessity, be in the form of latent heat of fusion. Also there are such factors as the proximity of the ground surface, heating and cooling effect of the air, moisture condition of the soil, and method of operation of the heat pump system, which make any simple theoretical study of virtually no practical value in determining the design of a ground coil for use with a heat pump system.

H. B. NOTTAGE, Cleveland, Ohio (WRITTEN): While the objective of this paper, implied in the first paragraph, is commendable and quite comprehensive, it appears that the all-important engineering basis for judging the calculations in relation to *the real heat flow system* has been elusively buried and camouflaged in the particular details of the numerical examples. Principles of *application thinking*, properly elucidated, are at times worth much more than examples.

The authors are called upon to set forth, in clear and simple terms, to what extent the general objectives have been fulfilled by the idealized system which has been postulated as the basis of their Equation 1. Do the "data not yet released for publication" offer further clarifying practical information? How can the engineer with a non-mathematical background learn to recognize when Equation 1 is *not valid*?

The steady-state solution, which here has been dismissed as a trivial result of value only in some kind of "special circumstances," would have practical use to establish appropriate limiting conditions, would it not?

Apparently the authors are unaware of the solution to their idealized system for pipes of finite diameter which was presented in 1931 by A. B. Newman (*Industrial and Engineering Chemistry* Vol. 23, p. 29, 1931).

R. C. CHEWNING, Portland, Ore. (WRITTEN): The formulas presented are based almost entirely on conduction of heat through the ground and the results obtained seem reasonable for this type of heat transfer. However, to use the amount of pipe, indicated in Example 1, to do the heating required for a house with an 80,000 Btu per hour heat loss for one month would be prohibitive. Approximately 3000 ft of pipe would be required.

There are installations which obtain this heat quantity from the ground with 1/3 to 1/10 of the 3000 ft of pipe indicated. Not only do these installations obtain the necessary heat for one month, but for six and eight months. These installations verify the theory that the important consideration in the sizing of coils to obtain heat from the ground is not the conduction of heat through the soil, but rather the movement of water and water vapor in the soil, carrying the heat with them and making possible exceedingly high rates of transfer.

The paper presents a good method of calculating the transfer of heat in dry ground to establish the poor economy involved in that type of a heat source. Further, it is an excellent contribution on a subject which must be investigated much further before reliable application data can be provided.

CARL F. KAYAN, New York, N. Y. (WRITTEN): Referring to the Ingersoll and Plass paper, this treatment of two dimensional heat flow in an infinite medium is a very welcome contribution

ASHVE Sends Greetings to IHVE

President Tuve said that it was an interesting coincidence that the Society and the British *Institution of Heating and Ventilating Engineers* were meeting on the same day and that he had sent the following message of greeting to President L. Copeland Watts:

ASHVE OFFICERS AND COUNCIL SEND CORDIAL GREETINGS AND BEST WISHES FOR A SUCCESSFUL MEETING OF IHVE.

A reply from Mr. Watts had been received as follows:

IHVE OFFICERS AND COUNCIL CORDIALLY RECIPROCATE GOOD WISHES OF ASHVE.

to the body of knowledge in this field. Certainly the effect of soil property values on validity of the final answer is well highlighted. The included tables and examples should prove very helpful in understanding problems of this type.

Comparison between small and large pipe, acclaiming preference of small pipe because of relative earth quantity, seems obscure and may be clarified. Also, reasoning on behavior of multiple pipe arrangements with respect to mutual effects is unclear and elaboration here would be helpful. Likewise not clear is the introduction of ground surface effects into the basic analysis.

AUTHORS' CLOSURE: As remarked in our paper, this is a *simple* treatment of the problem. There are a number of much more complex treatments, but the difficulties involved in their application are of an entirely different order of magnitude as compared with those in the present case. Newman's solution mentioned by Mr. Nottage is in this category.

To answer the questions about the application of this theory to various pipe sizes, it may be said that it is not difficult to calculate the conditions under which this theory holds *accurately* for any size of pipe, but the explanation might occupy more space than could be well afforded. Suffice it to say that the error involved in applying this theory to a 1 in. pipe after an hour of operation is of the order of only a percent or so. For a 2 in. pipe it is a little more, but the error becomes less as the time increases. From a practical standpoint the error is negligible for pipes of such sizes.

As indicated in the paper, this theory can take account of loops or grids and of ground surface effects. It cannot, obviously, calculate the effect of underground moisture diffusion or water flow. Nor can it take account of latent heat of freezing. It is questionable, however, if this is usually as important as is sometimes assumed.

Finally it must be understood that our paper is not intended in any way as a blue print for heat pump installing engineers; but is merely a guide to aid experimental research in this field. If it can point the way towards profitable lines of research and away from less promising ones (*e.g.*, from large pipes, coils, closely spaced grids, etc.) we shall consider that it has served its purpose.

Mr. Stacey introduced H. E. McGregor, Boston, a director of the *Heating, Piping and Air Conditioning Contractors National Association*. Mr. McGregor stated that he represented Thomas L. Eagan, Washington, president of the Association, and that Mr. Eagan had requested him to give his personal greetings to the Society, and to state that the *Heating, Piping and Air Conditioning Contractors National Association* was greatly interested in the panel heating research program of the Society and expected to contribute financial support to this program.

Mr. Stacey thanked Mr. MeGregor for his remarks and for the interest expressed in the Society's research program.

The third paper, **Fan Selection by Use of Constants, by A. C. Stern and Leon D. Horowitz,** (published in the June 1948 JOURNAL SECTION, *Heating, Piping & Air Conditioning*) was presented by Mr. Stern.

Verbal discussions were presented by W. L. McGrath, Syracuse, N. Y., and A. C. Bartlett, Hyde Park, Mass.

The meeting was adjourned at 12:00 noon.

Third Technical Session, Wednesday, June 23, 9:30 a.m.

President Tuve called the third session to order at 9:30 a.m. and requested Second Vice-Pres. L. T. Avery to take charge of the meeting. Mr. Avery introduced L. N. Hunter, chairman of the Committee on Research, who presented an outline of the research program of the Society.

Report of the Committee on Research

Mr. Hunter said that the report of the Committee on Research would consist of two parts.

1. A discussion of some of the matters of general interest that have come before the Committee and of actions that have been taken.

2. A brief review by the Director of Research on the current status of work going on in our own laboratory and in cooperating laboratories.

Technical Advisory Committees

The Committee on Research at its June 20 meeting authorized the setting up of a Technical Advisory Committee on the Heat Pump to study the many proposals submitted within the last few months. He said that there was increasing interest in the study of odors and that the subject would be explored further, but that it was not intended that a Technical Advisory Committee be appointed on this subject at this time. Mr. Hunter emphasized the value received by the Society in the contribution of the time of the members of Technical Advisory Committees who were experts in their respective fields.

The scope of each Technical Advisory Committee had recently been reviewed and clarified.

He briefly mentioned the projected visit of the Director of Research to England (see page 143).

Research Policy

Society policy requires, Mr. Hunter said, that we extend our research activities. This involves several problems.

1. The problem of finding more research projects. The most difficult part of this problem is the selection of projects that we are sure are of greatest interest and importance to our Society.

2. The problem of financing the projects becomes greater. At present approximately 40 percent of our research work is financed from dues paid by members, about 15 or 20 percent by in-

come from expositions, and the balance from general and earmarked contributions from industry and others. It would appear that additional finances for an expanded research program will have to come largely from industry and others.

3. The Committee feels that the success of our research is going to depend largely on our members becoming more intimately interested in our research work. Every member of the Society should have an active and definite interest in some phases of our research program. This problem has been discussed by the Committee and it has been agreed that each member of the Committee should make it a point to discuss our research work with as many of our Society members as possible and reflect this thinking back to the Committee so it can be taken into consideration in the development of future programs. We invite criticisms of our programs and we most certainly welcome constructive suggestions that can be used in making up these programs, said Mr. Hunter.

There are several steps being taken by the officers of the Society and by other committees and by individuals to help publicize and to keep you better informed on what is going on.

The Council has asked the Committee to extend our work in the fields of physiological and cooperative research. Eight cooperative projects were approved by the Committee this week and several other proposed projects are being referred to T. A. Committees for study and recommendations.

Some of these projects involve physiological work, and we are actively working on the development of other projects in this field.

The Council has also instructed us to accept Federal Government sponsorship and support in research work on fundamental problems involving heating, ventilating and air conditioning, and steps are being taken to obtain such support.

At the request of Mr. Hunter, Cyril Tasker, director of research, gave a report on the current status of Laboratory work.

Address by Director of Research

The Director reported that satisfactory progress was being made in three major projects, in six other projects at the Laboratory and in the four studies being made at cooperating institutions.

The studies under the Technical Advisory Committee on Air Cleaning, though primarily designed to develop an acceptable filter test code, must of necessity be concerned also with the fundamentals of filtration. This subject is a difficult one and will need a concentrated attack if substantial progress is to be made in a reasonable time.

The panel heating research program (Group A) was proceeding at a steady rate. A progress report had recently been made to the Technical Advisory Committee.

Since Mr. Parmelee was reporting progress in the studies under the Technical Advisory Committee on Heat Flow Through Glass, Mr. Tasker said he would not discuss the program except to point out that no part of this program was concerned with the testing of glass products of any kind. The studies, he pointed out, were fundamental and were designed to produce and were producing physical constants which later would be translated into engineering data for the solution of problems involving solar radiation.

Under the guidance of the Technical Advisory Committee on Air Distribution Mr. Nottage had made an exhaustive literature survey and analysis on the fundamentals of turbulence as part of a long range program on ventilation jets. Material for a short paper and a research bulletin was now in preparation. The experimental portion of the program was now under way at the Laboratory. The subcommittee on duct friction had collected a great deal of information on friction through fittings; this was now being analyzed and correlated, preparatory to the development of an experimental program.

Cooperative Studies

Cooperative studies were under way at Case Institute and Kansas State College on the performance of perforated ceiling panels and the downblow of heated air respectively.

Plans were in hand to develop more data on sol-air temperatures and on the sol-air thermometer. The Technical Advisory Committee on Cooling Load was actively pursuing a program to develop more accurate data for cooling load calculations.

The Technical Advisory Committee on Industrial Ventilation, meeting the previous day, had made good progress in its plan to get into the hands of the membership more dependable data for the solution of problems in industrial ventilation and process air conditioning.

The program under the Technical Advisory Committee on Insulation was well in hand, samples of insulation checked by 16 laboratories had now been examined by the National Bureau of Standards, which reported quite compatible results to date.

The physiological studies at the University of Illinois had already been reported on by Prof. Glickman. These studies were of great importance to the Society, and the active participation of the staff of the University of Illinois Medical School deserved special mention.

Mr. Tasker briefly mentioned the projected physiological studies which it was expected, would be made in cooperation with the Office of Naval Research. More details would be available as soon as the contract details had been settled and the program set in motion.

The second series of investigation on the burning characteristics of fuel oils was nearing completion. The cooperative studies, which were being sponsored by the Oil-Heat Institute of America, would be reported on in detail at a later date.

For the past several months copies of the Director's bi-monthly report to the Committee on Research had been sent to the Chapter Relations Committee for transmittal to the chapters. There had been a large number of visitors to the Laboratory in recent months. Members would always be welcome if they wished to visit the Laboratory and see the experimental work in progress.

Mr. Tasker said that the Laboratory now had a staff of which the membership could be proud, and that the staff worked as a team. It was encouraging to them to discuss the program with the membership on all possible occasions.

SOLAR HEAT STUDIES PROVIDE IMPORTANT DATA

Mr. Avery introduced J. P. Stewart, Syracuse, N. Y., and stated that the paper about to be presented had been prepared at the suggestion of the Research Technical Advisory Committee on Cooling Load. Mr. Stewart then presented his paper, **Solar Heat Gain through Walls and Roofs for Cooling Load Calculations** (see page 121 this issue).

Written discussions were presented by H. B. Nottage, Cleveland, Ohio, C. S. Leopold, Philadelphia, Pa., C. O. Mackey, Ithaca, N. Y., G. V. Parmelee, Cleveland, Ohio, and by W. E. Zieber, York, Pa., and published with the paper (see page 131 this issue). Verbal discussion was presented by C. M. Humphreys, Cleveland, Ohio.

The second paper, **Hydraulic Analogue for the Solution of Problems of Thermal Storage, Radiation, Convection and Conduction,** by C. S. Leopold, was presented by the author (published in the July 1948 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

J. F. STONE, New York, N. Y. (WRITTEN): The Analogue described by Mr. Leopold does not depart in principle from the one devised by Prof. A. D. Moore, University of Michigan, but it is interesting to see the practical inventiveness of the engineer in varying the

construction and operation to eliminate the difficulties which caused difficulties for Professor Moore.

It may be suggested that the analogue is not as flexible as would be desirable if an engineering organization expects to study a considerable number of problems which present significant variations. It is true that the preparation and calibration of the required conductance tubes will take some time, but once prepared and with the characteristics recorded, it will be found that a moderate number will handle a large range of problems. The variation of unit heat conductance, and to lesser degree heat capacity of building materials and insulants, is such that extremely accurate refinements in calculation or measurements bring to mind the cub surveyor who paced off a field and reported its area to tenths of a square yard.

Neither is the time required to prepare the flow restrictors which represent conductances a valid argument for substitution of paper and pencil. The calculator is faced with the same variations in properties of materials and the consequent introduction of uncertainties, and what is worse to most of us who have been out of school for some considerable time, the actual difficulty of correct mathematical manipulation is such that, as Mr. Leopold says "it is definitely a task not to be lightly undertaken, if at all." We have to deal with two major factors multiplied by the number of materials present in the contemplated structures, namely resistance to heat flow and thermal storage effect. The minatory appearance of these parameters in the Fourier differential equation for heat flow,

$$\frac{\partial T}{\partial t} = \frac{k}{\rho c}\left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{\partial^2 T}{\partial z^2}\right)$$

where,

T = temperature
t = time

is not lessened by the knowledge that ρ, density, and c, specific heat, as well as k, the conductivity, are likely to be known only within 10 percent.

The very interesting and significant results secured by Mr. Leopold with his machine seem to this reviewer all the proof needed that the Analogue, in competent hands, is a tool of high utility.

F. C. Wood, York, Pa. (Written): Mr. Leopold in this excellent paper progresses another step in his fundamental research into the mechanism of structure heat transfer. His ingenious hydraulic analogue brings to light results on the effects of heat storage phenomena that are somewhat startling and, judging from the answers obtained, of truly important engineering significance.

It is questionable whether many in the industry have appreciated the true magnitude of heat storage effects, and the very considerable time lag that occurs before a substantial percentage of the heat given off by source loads, having large radiant components, appears as an apparatus load. Conventional load calculation practice is and has been ultra-conservative, judging from the graphed results of these experiments. Fig. 2, *Problem B* of the paper shows that with air supply and temperature controlled to hold constant room temperature, the load removed by the air supply after 8 hr operation (normal daily building occupancy period) is predicted at barely 70 percent of the constant source load, and rises to only 76 percent even after 14 hr operation. The theory supports the premise that the air supply load removal curve will become asymptotic to the constant room load curve (as long as a floor to ceiling radiation component exists), and, judging from the gradual slope of the former, it would appear that even doubling the span to 28 hr operation would still result in no more than about 85 percent air supply load removal.

Subtracting the lamp convective load component A, Fig. 3, (32.9 percent of the total source energy, which may be assumed to be absorbed practically instantaneously by the air supply) the true lag due to thermal storage and conduction in cooling apparatus absorption is found to be 67.1 percent lamp radiant load component. For example, Fig. 2, *Problem B* shows the air supply load absorption after 8 hr operation to be 68 percent of the total heat gain from the source. After deducting the 32.9 percent direct lamp convective load, the remaining 35.1 percent represents the cooling apparatus pick-up of the lamp radiant load after 8 hr of operation. This is seen to be only $\frac{35.1}{67.1} = 52$ percent. After 14 hr, the apparatus still has absorbed only 64 percent of the radiant heat gain component. If these represent true occurrences, how fallacious has been the concept of calculating such gains as instantaneous cooling apparatus loads!

It is to be hoped that out of experiments of this nature, extended to observance of the effects on cooling load of other sources of radiant energy, particularly solar radiation, will come authentic design factors that compensate for thermal storage and convective heat exchange lag and result in reduced calculated cooling apparatus loads. Such permissible design latitude would be particularly advantageous today in the light of modern trends to heavy light wattage densities and large window glass exposures. Frequently these effects increase seriously the air supply densities—to plague the designer with air distribution problems, with increased air cycle first costs and space requirements.

Also, true recognition of the effects of thermal storage of radiant energy received by the room surfaces would indicate, possibly, that zoning need not be as extensively employed as has heretofore been customary in quality installations. In this connection, the results of the author's current investigations of room temperature variations in three unequally loaded rooms in the same zone served with constant supply air temperature should be of considerable interest.

The work that the author is carrying on as reported in this paper and in others on panel cooling[1], is unquestionably of noteworthy engineering significance to the industry. His concepts are original and even revolutionary by past standards, yet appear practical from an application standpoint and as such represent a definite contribution to the advancement of the art. The possibilities of panel cooling, in combination with panel heating, offering the highest quality in air conditioning for comfort appear to warrant the most extensive research of the subject within the industry with the objective of establishing authentic, readily usable application design data and standards. The lack of such information at present severely handicaps the application generally of this type of system.

The verbal comments were presented by W. L. McGrath, Syracuse, N. Y., C. O. Mackey, Ithaca, N. Y., and by G. V. Parmelee, Cleveland, Ohio.

The third paper, **Solar and Total Heat Gain Through Double Flat Glass,** by G. V. Parmelee and W. W. Aubele, (published in the June 1948 Journal Section, *Heating, Piping & Air Conditioning*) was presented by Mr. Parmelee. A verbal discussion of the paper was presented by W. M. Wallace, II, Durham, N. C.

Mr. Avery then called on I. W. Cotton, chairman of the Resolutions Committee, who presented the following resolutions which were adopted unanimously:

Resolutions

WHEREAS, the 1948 Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers has been a complete, unqualified success, therefore,

BE IT RESOLVED; that we, who received the countless delights and benefits which highlighted this occasion, extend our sincere thanks:

To the Officers and Members of the Massachusetts Chapter who invited us,

To Mr. C. M. F. Peterson and his Arrangements Committee who planned so carefully and executed arduous tasks so efficiently,

To Mr. J. J. Hennessy, Manager of the Mount Washington Hotel, and his courteous

[1] The Mechanism of Heat Transfer, Panel Cooling, Heat Storage, by C. S. Leopold. (*Refrigerating Engineering*, Part I, July 1947, p. 33, and Part II, June, 1948, p. 571.)

staff who provided every comfort and served us perfect meals,

To Miss Ruth Landi and Eric Langer and his Orchestra, for fine music, good entertainment and just plain fun,

To the White Mountains, for their inspirational background of matchless scenery and historic interest,

To the Society Officers and staff who carried out the great mass of necessary routine detail incident to the meeting with characteristic efficiency,

To the Program Committee, the authors of the technical papers and those who discussed them, for many contributions to our art and for a wealth of interesting engineering data,

To Prof. E. H. Stolworthy of the University of New Hampshire, for his fascinating pictures and interesting description of Mt. Washington with its "world's worst weather",

To 20th Century-Fox Studios for a preview of an excellent picture which held out hope for success in life—even to us engineers,

To our banquet speaker, to whose address we all look forward,

To the Technical press, for excellent advance publicity and the fine reports of the meeting we know will be published later,

To all those golfers—regardless of handicap—whose devotion to duty is to be commended far more than the length of their drives or the accuracy of their putts, and

BE IT FURTHER RESOLVED, that a copy of these resolutions be incorporated in the minutes of this meeting.

Respectfully submitted,

RESOLUTIONS COMMITTEE,

Arthur J. Hess
C. M. Burnam, Jr.
I. W. Cotton, *Chairman*

P.S. BE IT RESOLVED ALSO THAT, thanks be given to said Resolutions Committee for preparing these splendid resolutions amidst the exciting distractions of smashing tennis players and swimmers of both the splashing and sunning varieties.

As there was no further business, Chairman Avery declared the Semi-Annual Meeting adjourned at 12:00 noon.

MEETINGS

On June 20 the Committee on Research held an all-day session and during the afternoon the Council discussed a schedule of future meetings and decided upon a meeting and exposition for the 4th week in January 1950 in Dallas, Tex.

Members were nominated to serve on the Committee on Research, commencing in January 1949 for a three-year term. Reports were received from the Council Committees and a new application form for Student Members was authorized. A petition for Amendment of **Article B-VIII, *Section 14*** was received and referred to the Constitution and By-Laws Committee.

President Tuve announced the personnel of the Committees on Research Promotion and Public Relations. The resignations of 14 members were accepted, and membership cancellations for non-payment of dues totalled 123.

CHAPTER DELEGATES

Two meetings of the Chapter Delegates were held and representatives from 24 Chapters were present. R. F. Taylor, Houston, Tex., chairman of the Membership Committee, made a report and answered a number of questions regarding the handling of the membership applications.

President Tuve gave a discussion on membership and outlined something about the work of the new Committee on Public Relations. D. M. Allen, Kansas City, Mo., chairman of the Chapter Relations Committee, explained the work of the committee and its relationship and the work with the Chapters. He stated that there were several sets of reports that were of interest to chapters covering the rules of procedure for chapter operation, and suggestions for improving local chapter meetings, rules for furnishing speakers, and suggestions for Chapter Public Relations chairmen.

There was considerable discussion on the report of the Committee to draft Chapter By-Laws and this report was referred to the Society's Committee on Constitution and By-Laws for review.

Chairman C. R. Gardner, Dallas, Tex., said that the delegates were interested in the status of the Research Mortgage Retirement Fund and A. V. Hutchinson, secretary, stated that all of the money contributed had now been allotted to the mortgage reduction and as of June 15 the balance due was $7600.

In reply to a question about the relation of Chapters to the Society H. E. Sproull, Cincinnati, Ohio, chairman of the Constitution and By-Laws Committee, and a former chairman of the Chapter Delegates Committee, said that the Chapter Delegates are a group whose purpose is to discuss ways and means of improving Chapters and their operation and that it is not concerned with the operation and government of the Society, which is a Council function. He pointed out that there were a great many things for the Chapters to do and the group was offered a splendid opportunity to get together and solve problems of mutual interest. He felt that having a Chapter Delegate for any extended period would be contrary to the purpose of the Chapter Delegates Committee, and it had been an unwritten law in his Chapter that the incoming president serves as Chapter Delegate.

Considerable time was spent in discussion of questions submitted by chapter members, including methods of obtaining members, chapter meetings; and news bulletins, methods of selecting Chapter Delegates and their term of service, more practical projects and papers from the Research Laboratory, and assistance in planning and conducting chapter meetings.

At the second session of the Chapter Delegates a number of officers and Council members attended, upon invitation of the chairman, and a brief discussion was held on the matter of dues increase, and a report was received on the advisability of Chapter Delegates serving more than a one year term.

COMMITTEES

During the meeting a number of the Technical Advisory Committees were in session and discussed subjects relating to air distribution, air friction, panel heating and cooling, heat flow through glass, and industrial ventilation.

The Guide Publication Committee held a long session in connection with the preparation of the 1949 edition of THE GUIDE, and those in attendance were: R. C. Cross, Chicago, Ill., Prof. A. B. Algren, Minneapolis, Minn., R. L. Byers, Cleveland, Ohio, R. P. Cook, Rochester, N. Y., Prof. Nathaniel Glickman, Chicago, Ill., Prof. B. H. Jennings, Evanston, Ill., H. R. Limbacher, Kalamazoo, Mich., W. M. Wallace, II, Durham, N. C., and W. N. Witheridge, Detroit, Mich.

On Monday evening the Nominating Committee held a meeting to select candidates for office for the coming year and this report will be made in September as required. Those present were: J. E. Haines, Minneapolis, Minn., *chairman;* R. H. Carpenter, New York, N. Y., *vice chairman;* F. C. McIntosh, Pitts-

55th ANNUAL MEETING IN CHICAGO

Plans are being made for the 55th Annual Meeting of the ASHVE in Chicago, January 24-27, 1949, by the Illinois Chapter, which will be host for the occasion. W. A. Kuechenberg is General Chairman of Arrangements. Headquarters for the meeting will be at the Stevens Hotel.

The 9th International Heating and Ventilating Exposition will be held during the same week at the International Amphitheater.

burgh, Pa., *secretary;* C. M. Ashley, Syracuse, N. Y., Leo Garneau, Montreal, Que., Canada, John James, Chicago, Ill., G. W. F. Myers, St. Louis, Mo., G. B. Supple, Indianapolis, Ind., W. M. Wallace, II, Durham, N. C., H. King McCain, Atlanta, Ga., and D. M. Mills, Houston, Tex.

ENTERTAINMENT

For those who arrived early, Bretton Woods and its surrounding mountain scenery provided many interesting side trips, as well as the regular events scheduled by the Committee on Arrangements.

On Sunday, Monday, and Tuesday a great many made the cog rail trip to the summit of Mt. Washington, or visited Franconia Notch to see the Old Man of the Mountains, Profile Lake, and the Flume. Those who made the trip on the aerial tramway to Cannon Mountain found this a thrilling trip. Others enjoyed the trip to Crawford Notch and North Conway, with the trip up Cranmore Mountain on the ski-mobile.

On Monday evening there was a special showing of a feature movie, *Give My Regards to Broadway,* which was followed by games and a barn dance in the ballroom.

On Tuesday afternoon there was a golf tournament for the Research and Eichberg Memorial Cups, and after 40 golfers had played their 18 holes, the low net score was made by A. C. Bartlett, Hyde Park, Mass., who received the Research Cup, and C. W. Johnson, Windsor, Ont., was runner up, while the low gross score was made by M. W. Bishop, Chicago, Ill. The Eichberg Cup was won by the New York Chapter team, consisting of Messrs. W. J. Osborn, F. J. Swaney, and J. F. Butterworth. Awards were also made to M. W. Bishop and W. A. Kuechenberg, Chicago, Ill., C. H. Schneider, Pittsburgh, Pa., C. F. Donohue, Detroit, Mich., W. R. Moore, Cleveland, Ohio, and E. L. Blair, Boston, Mass.

Name	Gross	Handicap	Net
Bartlett, A. C.	92	26	66
Blair, D. W.	107	30	77
Blair, E. L.	154	30	124
Law, R. W.	102	22	80
Bishop, W. F.	97	18	79
Osborn, W. J.	87	14	73
Butterworth, J. F.	104	30	74
Sterk, B.	120	30	90
Swaney, F.	100	26	74
Hewett, J. B.	109	30	79
Smith, C. H.	108	20	88
Heath, W. R.	132	30	102
Saunders, L. P.	105	20	85
Wiggs, G. Lorne	106	30	76
Noyes, R. R.	127	30	97
Johnson, C. W.	99	30	69
Thompson, J.	94	22	72
Miller, W.	118	30	88
Myers, G.	102	24	78
Bishop, M. W.	85	13	72
Schneider, C. H.	98	28	70
Matchett, J. C.	110	30	80
Kuechenberg, W. A.	95	16	79
Avery, L. T.	101	19	82
Moore, W. R.	100	23	77
Park, P. S.	101	30	71
Donohoe, C. F.	108	28	88
Moore, R. E.	92	15	77
Milliken, J. H.	96	15	81
Blankin, M. F.	91	18	73
Brutschy, F.	98	24	74
Driscoll, W. H.	119	30	89
Hedges, B.	120	25	95
Lawler, M. M.	—	30	—
Fife, G. D.	105	26	79
Haynes, C. V.	102	30	72
Byers, R. L.	123	30	93
McKeeman, C. A.	110	30	80

In the ladies putting contest, in which 20 participated, Mrs. M. G. Kershaw, Philadelphia, Pa., made the best score.

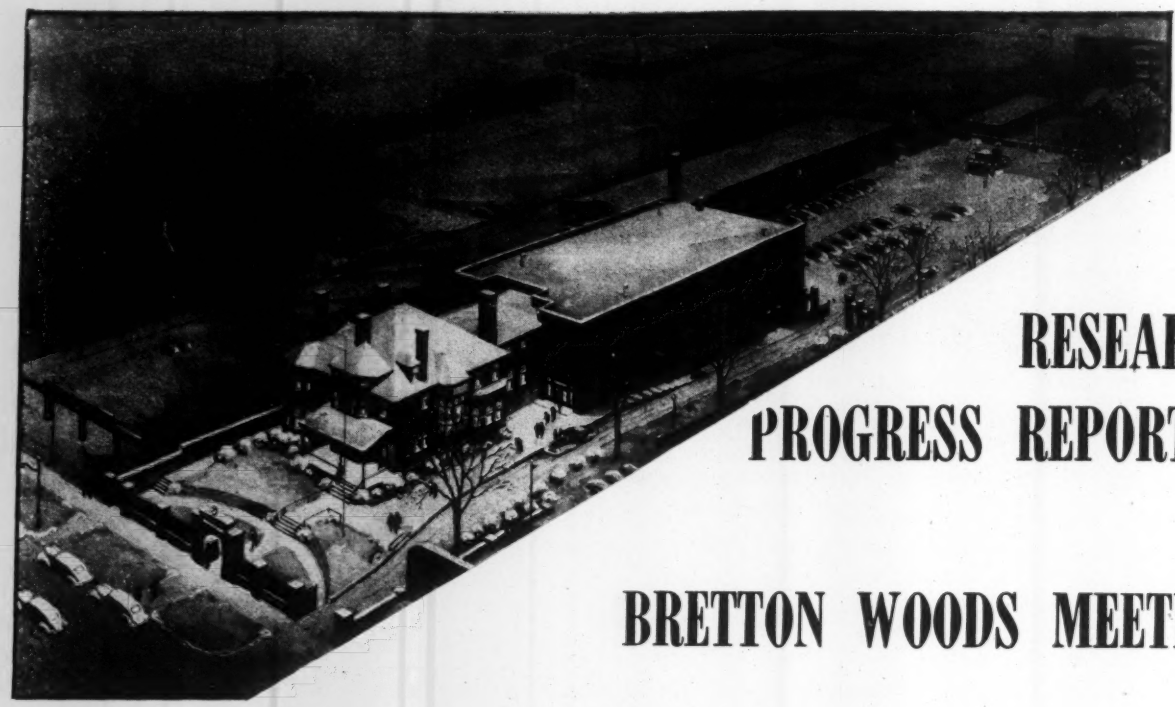
On Wednesday 54 ladies attended the card party and the following awards were made: Mrs. M. G. Kershaw (two silver cigarette urns); Mrs. D. M. Mills, Houston, Tex. (gold leather evening bag); Mrs. Earl Carrier, Winchester, Mass. (six aluminum tumblers); Mrs. Howard Limbacher, Kalamazoo, Mich. (large copper bowl); Mrs. Burgess Jennings, Evanston, Ill. (pewter porringer); Mrs. Robert Blanding, Providence, R. I. (eight silver ash trays); Mrs. Ernest Blair, Wollaston, Mass. (hand painted tray); Mrs. Roswell Farnham, Buffalo, N. Y. (reflection mirror); Mrs. Charles Smith, Newark, N. J. (two figurines—*Mr. and Mrs. Beacon Hill*); Mrs. Herbert Parker, North Quincy, Mass. (Vermont pottery vase); Miss Ruth L. Carpenter, White Plains, N. Y. (Boston handkerchief); Mrs. G. M. Ellis, Orchard Park, N. Y. (Boston handkerchief); Mrs. Leon Munier, Hartsdale, N. Y. (Boston handkerchief); and Mrs. R. H. Carpenter, White Plains, N. Y. (Boston handkerchief).

As rain started to fall during the afternoon, the softball game, some golf matches, and the other athletic events were cancelled in favor of indoor games.

On Wednesday evening the banquet was held in the main dining room and Prof. James Holt, Cambridge, Mass., served as toastmaster. Following dinner Professor Holt called upon L. N. Hunter, chairman of Committee on Research, to present the Research Cup to the winner, A. C. Bartlett. Mr. Bartlett then presented the Eichberg Memorial Cup to the New York Chapter and W. J. Osborn received it on behalf of the Chapter.

President Tuve expressed the gratification of the members for the fine meeting that had been enjoyed and the excellent hospitality of the Massachusetts Chapter. He introduced W. A. Kuechenberg; Chicago, who extended a cordial invitation to all present to come to Chicago for the Annual Meeting in January 1949.

Dean L. E. Seeley, Durham, N. H., was called upon to introduce the speaker of the evening, Laurence Whittemore, president of the Federal Reserve Bank of Boston, who spoke on The More Abundant Life and how invention and ingenuity were prime factors in the development of the country and in giving us our present high standard of living.



RESEARCH PROGRESS REPORTED AT BRETTON WOODS MEETING

The Committee on Research under the chairmanship of L. N. Hunter held a full-day meeting on June 20 at the Mount Washington Hotel, Bretton Woods, N. H., during the Semi-Annual Meeting of the Society. Twelve members were in attendance. Dr. Thomas Bedford of the Medical Research Council, London, England, attended at the invitation of the Chairman.

Important highlights of the meeting and of the decisions taken were:

1. The research budget for the 1948 fiscal period was increased by $6050 to $102,150 to cover increased cooperative research and additional work in solar radiation transmission.
2. Industrial support from November 1, 1947, to June 15, 1948, totaling $45,077 in cash and pledges was reported by C. A. McKeeman, Assistant to the President, who also reported that the *Institute of Boiler and Radiator Manufacturers*, the *Heating, Piping and Air Conditioning Contractors National Association*, the *Metal Window Institute*, the *Association of American Railroads*, and the *Oil-Heat Institute of America* were all giving financial support to the Society's research program in addition to the many organizations throughout the industry whose support had made possible the expanded program now under way.
3. The Director of Research reported on 11 projects actively under way at the Laboratory and four projects active at three cooperating institutions.
4. The Committee redefined the scope of the activities of most of the technical advisory committees and authorized the appointment of a new Technical Advisory Committee on the Heat Pump.
5. The Committee authorized the renewal of contracts for research on a cooperative basis with three institutions. It also authorized new contracts with four institutions. Cooperative contracts in 1948-49 will be under way as follows:

a. Physiological Adjustment of Human Beings to Sudden Changes in Environment	University of Illinois, College of Medicine, Chicago
b. Performance of Perforated Ceiling Panels	Case Institute of Technology
c. Downward Flow of Heated Air	Kansas State College
d. The Radiant Effect in Sensory Reactions to Comfort	Kansas State College
e. Effect of Size of Sol-Air Thermometer on Readings of Sol-Air Temperature	Cornell University
f. Development of Sol-Air Temperature Data for New Orleans	U. S. Weather Bureau, Tulane University
g. Study of Friction in Branch Off-take Fittings in Rectangular Ducts	Michigan State College
h. Effect of Idle Pipes on the Temperature Field and Heat Flow in a Concrete Panel	Columbia University

6. The Committee approved a plan prepared by the Research Executive Committee and the Faculty of Case Institute of Technology whereby members of the Research Laboratory staff may take advanced degrees at Case.
7. The employment of an additional temporary staff for the summer months was approved. C. M. Humphreys was appointed acting Director of Research for the period August 14 to October 14, 1948, *i.e.*, during Mr. Tasker's absence from the country.
8. Arrangements were made for a full-day meeting of the Committee at the Laboratory on September 17, 1948, to approve the research budget for 1949.

Meetings of five technical advisory committees were held at Bretton Woods during the Semi-Annual Meeting:

- Technical Advisory Committee on Panel Heating and Cooling (G. D. Winans, chairman)
- Technical Advisory Committee on Air Distribution (Dean L. G. Miller, acting chairman)
- Technical Advisory Committee on Industrial Ventilation (W. N. Witheridge, chairman)
- Technical Advisory Committee on Heat Flow Through Glass (R. A. Miller, chairman)
- Technical Advisory Committee on Cooling Load (W. E. Zieber, chairman)

Director of Research to Visit British Isles

L. N. Hunter, chairman, Committee on Research, announces that Cyril Tasker, director of research, has been invited by the Joint Committee on Heating and Ventilation of the Fuel Research Board and Building Research Board, Department of Scientific and Industrial Research, to visit England to discuss the research work going on in the British Isles in connection with house heating, insulation, comfort, industrial ventilation, etc.

The Committee on Research approved the acceptance of the invitation, and Mr. Tasker will leave New York on August 14 for England, returning to the United States by mid-October.

He will visit many research laboratories, experimental stations and housing sites where large scale tests are in progress and in particular will discuss experimental work now going on under the direction of the Building Research Board, Fuel Research Board, Gas Research Board, Medical Research Council, British Coal Utilization Council, National Coal Board, and National Physical Laboratory.

He will represent the Society at the Ninth International Congress on Industrial Medicine to be held in London, September 13-17, and which will be attended by several other Society members among whom are Dr. Leonard Greenburg and Prof. Philip Drinker.

Mr. Tasker has also accepted an invitation from L. Copeland Watts, president of the *Institution of Heating and Ventilating Engineers*, to present a paper before a special meeting of the Institution in London on September 29. His paper will deal with Research for the Heating, Ventilating and Air Conditioning Engineer.

Mr. Tasker will report to the Committee on Research on his return and to the Society at the 55th Annual Meeting in Chicago in January 1949.

New Bibliography on Panel Heating

C. M. Humphreys, senior engineer of the ASHVE Research Laboratory, with the assistance of Miss Doris M. Dietz, of the Laboratory staff, recently completed the compilation of an extensive bibliography of published literature on panel heating. In many cases a brief abstract or critical review was made and included in the compilation which contains over 330 references and is being reproduced in mimeographed form.

Members of the Society may obtain one copy of this bibliography without charge by writing to the ASHVE, 51 Madison Ave., New York 10, N. Y. Additional copies are 50c each.

Non-members may obtain copies by writing to Society Headquarters and enclosing remittance of 50 cents for each copy, available September 15.

Research Bulletins for Members

In accordance with action of Council, a copy of each Research Bulletin, when published, will be available to ASHVE Members upon application. In the June JOURNAL reference was made to the availability of Research Bulletins Nos. 2 and 3. This announcement is to advise the membership that one copy of each Bulletin can be obtained without charge, if a request is made to the Secretary of the Society during the period August 1 to October 31, 1948.

Research Bulletin No. 1 (now ready for press) entitled Heat Transmission Through Glass: *Part I*—Overall Coefficients of Heat Transmission of Windows and Glass-Block Panels; *Part II*—Solar Heat Transmission by Windows and Glass Block Panels. *Part I* of this report classifies and tabulates test data and presents comparisons with calculated values. In *Part II* data pertaining to solar heat transmission through windows and glass blocks have been reviewed, abstracted, and correlated.

Research Bulletin No. 2 (36 pages) is entitled The Thermal Properties of Building Materials Used in Heat Flow Calculations and makes available results of a search of literature for the purpose of compiling ready-reference data on the thermal conductivity, density and unit heat capacity of common building materials. While the data obtained are not so extensive nor so accurately established as might be desired from a fundamental viewpoint, they are felt to be satisfactory in meeting current needs for practical air conditioning load estimates which are to include the effects of the periodic nature of the heat flow through walls and roofs.

Research Bulletin No. 3 (48 pages) is entitled Forced Convection Heat Transfer from Flat Surfaces and presents the results of tests in which a vertical smooth flat surface was swept by a horizontal parallel stream of air. Data are given for turbulent, laminar, and transitional boundary layer flow along the surface and show the effects of air velocity and surface length. The experimental results obtained have been correlated with the theoretical heat transfer which would be computed from equations based on analogy of skin friction and heat transfer. By means of these equations useful extensions of data may be made.

JOURNAL SECTION

Summary of Local Chapter Meetings*

CENTRAL NEW YORK—May 26, 1948. Members and guests of Central New York Chapters of ASHVE and *ASRE* attended a joint meeting, which was in the form of an outing and clambake. Many games and activities were available and a particularly enjoyable feature was the softball game between the two Societies, with the ASHVE as the winner. It was very apparent that everyone was having a good time. During dinner, many awards were made and the officers of the *ASRE* Central New York Chapter were installed. No formal adjournment was called for, and many stayed on to participate in cards and conversation. Attendance 80.

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CINCINNATI—April 6, 1948. A very interesting talk on Aluminum Duct Work as applied to the air conditioning, heating and ventilating industry, was presented by P. E. Brandt, technical engineer, Reynolds Metals Co. Accompanying the talk was a 16 mm movie film showing the manufacture of aluminum in its various phases. The chapter heartily recommends Mr. Brandt's talk to anyone interested in this subject. The nomination of officers for the coming year was reported by A. W. Edwards, chairman of the nominating committee. Elections will take place at the annual outing to be held later. H. E. Sproull reported on the activities of the ASHVE Council meeting. Attendance 59.

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CONNECTICUT—May 25, 1948. The Standing Committees for the fiscal year 1948-49 were announced by Pres. E. C. Marsden. He also announced the appointment of the following: Chapter delegate—S. R. Osborne, Alternate — Winfield Roeder; *Advisory Council*—C.-E. A. Winslow; *Nominating*—H. E. Adams. An announcement was made of the June 15 meeting in Springfield, Mass., of the *American Society of Refrigerating Engineers*. T. A. Walters, research director of the American Blower Corp., was the speaker of the evening. Attendance 43. Attendance ratio 0.20.

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MANITOBA—April 15, 1948. Subject: Professional Air Control in 1960. Speaker: G. L. Tuve, president of the ASHVE, and professor of mechanical engineering, Case Institute of Technology. Professor Tuve called attention to a number of technical problems that have not yet been solved to the satisfaction of either the industry or the public. The opportunities and responsibilities of the Society and its members were outlined by Professor Tuve, with emphasis on the professional status of the engineer and his responsibility to other engineers and other groups, such as the medical profession. Suggestions made by Professor Tuve were that the Manitoba Chapter collaborate with the Minneapolis Chapter for a summer meeting and that the Manitoba Chapter make some arrangements with the University of Manitoba so that chapter members could participate in research work. A vote of thanks was accorded Professor Tuve for a very fine talk. Other Features: Nominations for officers for the coming year were presented by the nominating committee. Attendance 36.

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MASSACHUSETTS — May 18, 1948. J. M. Kane, chief engineer, Dust Control Division, American Air Filter Co., Inc., spoke on the Use of Local Exhaust Ventilation for Control of Dust in Industry. In his talk, Mr. Kane covered several subjects. He began with the elements of an exhaust system for removal of dust from industrial processes, and compared such systems with the usual heating, ventilating and air conditioning systems. He then went on to mention the design features of exhaust hoods and enclosures for picking up industrial dusts, and the importance of giving careful consideration to this phase of the exhaust system. Methods of removing the collected material from the air stream were also included, as well as the reason for difference in design between industrial dust control collectors and air filters used for atmospheric air cleaning. He said there is a need for supply air and that there is a possibility of recirculating clean air from exhaust systems. Mr. Kane illustrated his talk with slides showing various types of dust control systems, and showed several *before*-and-*after* samples to demonstrate the value of dust control installations. During the discussion period, Mr. Kane was asked many questions, and his answers were based on personal experience. Attendance 52. Attendance ratio 0.62.

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MEMPHIS—May 17, 1948. In the absence of Pres. E. E. Scott, Vice-Pres. W. E. Thorpe called the meeting to order. After the minutes of the previous meeting had been read and approved, nominations were in order for the new member of the Board of Governors for a three-year term. R. W. Johnson was elected by acclamation. C. S. Fischer submitted a Treasurer's report showing a balance of $194.53 cash on hand and in the bank. T. O. S. Humphrey, Jr., chairman of the Meetings Committee, called on W. F. Slater to introduce the speaker, A. G. Hillen, branch manager of the St. Louis office of the Carrier Corp. The Conduit Weathermaster System was the subject of Mr. Hillen's interesting talk. Attendance 32.

*Note: The attendance ratios shown represent the membership attendance divided by the chapter membership. These ratios will be useful as a partial indication of interest shown by local chapter members in various types of subjects programmed by the various chapters and may be useful in deciding on subjects for chapter meetings.

MINNESOTA — May 3, 1948. The speaker of the evening was Prof. William Goodman, Illinois Institute of Technology, Chicago, Ill., who gave a very interesting talk on Design and Control of Year-Round Air Conditioning Systems. Prof. Goodman used slides to illustrate his talk, and a large number of members took part in the discussion that followed. Pres. L. C. Gross announced the results of the election as follows: *President*—O. L. Lilja; *Vice President*—R. C. Jordan; *Secretary*—E. F. Snyder; *Treasurer*—B. F. McLouth; *Board of Governors*—L. C. Gross, D. B. Anderson, C. T. Lawrence. Prof. A. B. Algren was chosen chapter representative to the *Minnesota Federation of Engineering Societies* with E. J. Uhl as alternate. It was announced that the chapter welcomed 32 new members during the past year. Attendance 95. Attendance ratio 0.44.

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NEBRASKA — June 8, 1948. The June meeting was held at the Council Bluffs Country Club, Lake Manawa, Ia., and with the exception of election of officers, was devoted entirely to entertainment features. Members participated in the various sports that were offered which included golf, horseshoe pitching, shuffleboard and swimming. Awards were distributed for all events, and it was obvious that everyone was having a thoroughly good time. The following officers were elected: *President*—K. R. Magarrell; *Vice President*—C. A. Carter; *Secretary*—F. E. Prawl; *Treasurer*—G. W. Colburn. Attendance 30.

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NORTH CAROLINA — April 16, 1948. Speaking on the activities of the Society's Chapter Relations Committee, C. Z. Adams suggested that a determined drive for new members be made. Along this line, he suggested the possibility of forming Eastern and Western North Carolina Chapters. He felt that this would make it much easier for members to attend meetings, and then the Western North Carolina Chapter could invite members from South Carolina to attend their meetings and promote the formation of a South Carolina Chapter. Pres. E. S. deWitt announced the formation of a Student Branch of ASHVE at North Carolina State College, Raleigh, N. C. A motion was requested by President deWitt regarding the best method of handling suggestions to the Society's Nominating Committee. After speaking briefly on plans for the summer meeting, R. O. McGary, chairman of the program committee, introduced the evening's speaker, Richard Reade, American Blower Corp., who gave a very interesting talk on Vane-Axial Fans. Attendance 69.

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NORTH TEXAS—May 10, 1948. An announcement was made by Vice Pres. G. A. Linskie, that the North Texas Chapter would be host to the Society in 1950, when the Annual Meeting would be held in Dallas. C. R. Gardner, who has done much work toward this end, said that there is still much work to be done, and asked for, and received volunteers to help in the many phases. An extremely informative and thrilling program was put on by G. M. Kintz, supervising engineer, Health and Safety Branch, U. S. Bureau of Mines. Assisted by H. F. Browne, petroleum engineer, and E. Podgarski, mining engineer of the Dallas office, Mr. Kintz showed movies on various explosions and fires. One particularly interesting film was of a fire in a downtown hotel in Dallas. The films were enjoyed by all the members. Attendance 55. Attendance ratio 0.55.

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OKLAHOMA—June 14, 1948. For this meeting, the last of the season, the program committee was fortunate in obtaining the talking, colored motion picture, *Boilers and Steam Generation*. The film was received with a great deal of interest and created considerable discussion. The chapter is indebted to the Visual Education Division of the University of Oklahoma and to H. L. Bowman for the showing of the film. After the new officers were installed, retiring Pres. W. W. Frankfurt was highly commended by the chapter for his successful year in office. His tenure resulted in an increase of 20 members. J. R. Patten was also acknowledged to be a real recruiting leader as chairman of the membership committee. The chapter vigorously applauded H. S. Shafer's efforts as chairman of the program committee for the arrangement of so many very interesting programs. Attendance 22. Attendance ratio 0.28.

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OREGON—May 6, 1948. The retiring president, C. W. Brissenden, expressed his appreciation to the officers, committees, and members for their cooperation during his term of office, and presented the Oregon Chapter Charter to Pres. E. R. Lokey. The question of chapter affiliation with the Oregon Technical Council was raised. A motion in favor of affiliation was made by B. W. Morrison, and approved unanimously by vote. At President Lokey's request, W. A. Simpson gave his report on the 5th Air Conditioning Conference. He said that the conference and exposition were both successful, and that through this success the chapter had gained much in public relations. He also made several valuable suggestions which should aid future conference committees. Discussion was carried on regarding a 6th Air Conditioning Conference to be held in 1949, and it was decided that further study should be made as to where it should be held and whether an equipment exposition should be included. More definite plans will be made at the September meeting. J. D. Kroeker announced that bindings for the past year Oregon Diffuser issues are again available. President Lokey commended Mr. Kroeker for his splendid accomplishments, during the past two years, as the editor of the Oregon Diffuser. Attendance 58.

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PACIFIC NORTHWEST—May 11, 1948. As this was the last meeting of the 1947-48 season, E. H. Langdon, re-

tiring president, presented the Charter to L. L. Bysom, newly elected president. The meeting was then turned over to the new president, who proposed a vote of thanks to the retiring president, and introduced the new officers. Several topics were brought up for general discussion. R. R. Kirkwood suggested that an effort be made to have the University of Washington reactivate its special course in heating and ventilating, and a suggestion was made by E. H. Langdon that more effort be placed upon obtaining members in the warm air business. The possibility of raising local chapter dues was mentioned, but no action was taken on this matter. Attendance 17.

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PHILADELPHIA—May 18, 1948. On behalf of the chapter, Past Pres. M. G. Kershaw presented Pres. E. H. Dafter with a bronze plaque in appreciation of his work during the past year. President Elect J. O. Kirkbride and the other officers for the coming year were introduced to the members by Retiring President Dafter. The meeting was then turned over to the golf committee chairman, W. P. Culbert, and H. H. Erickson, who distributed the golf awards won in the annual golf outing held that afternoon. The prizes were donated by members. Attendance 105.

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ROCKY MOUNTAIN—April 7, 1948. P. W. Young, in the absence of A. W. Cooper, chairman, presented the slate of the nominating committee for officers for the ensuing year. *President*—F. Janssen; Vice *President*—E. J. McEahern; *Secretary*—F. C. Allen; *Treasurer*—A. W. Cooper; *Board of Governors*—J. F. Mohan, H. W. Marshall, and H. J. Woehlke. The chapter was very fortunate in having as guest speaker G. L. Tuve, president of the Society, Cleveland, Ohio, who, before giving his talk on air control, outlined the activities of the Society and discussed future plans. He presented slides showing trends and distribution of the membership and outlining the activities of the Society, and asked the members to contribute any opinions and suggestions that they might have. President Tuve then spoke on the problem of air control and distribution in occupied spaces. Slides illustrating the fundamental principles of air distribution were shown, and a forecast was made of future trends and developments in heating and ventilating. According to President Tuve, the trends might be toward continuous air circulation, more outside air, and more automatic control. Future developments, he said, may be toward the use of solar heat, the heat pump and atomic energy. When President Tuve was through speaking, Pres. J. F. Mohan thanked him for his very fine talk. Attendance 35. Attendance ratio 0.49.

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SOUTH TEXAS—April 16, 1948. Subject: Axial Flow Fans. Speaker: W. R. Heath, assistant chief engineer, Buffalo Forge Co., Buffalo, N. Y. Mr. Heath spoke on axial flow fans, making comparisons with the other marketed types of fans. Other Features: B. P. Fisher, chairman of the 4th Annual Air Conditioning Conference to be held April 23, 27, and 28, at College Station, Tex., announced details of the Conference. Wayne Long of the Texas A. & M. College also spoke briefly on scheduled events of the Conference. S. E. Ammons, president of the Student Branch at the Texas A. & M. College, announced a joint meeting of the three Texas Chapters to be held at College Station on May 11. Sidney Bromberg was appointed to handle reservations for a coming Atomic Symposium to be held at the Rice Hotel, Houston, May 1, 1948. A nominating committee for 1948 officers was appointed by D. M. Mills, chapter president. Attendance 84.

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SOUTHERN CALIFORNIA—June 16, 1948. In answer to Leo Hungerford's question as to whether anyone present had information on glycol vapor in air conditioning, Fr. Walters reported that he had done considerable research on the subject. Mr. Walters then gave a short talk pointing out that the use of vapor as a germicidal agent has a definite place in air conditioning and should be considered further.

R. A. Lowe, president, proclaimed this last meeting of the season as Past Presidents' night, and suggested that the practice be continued. Mr. Lowe gave a short talk on the organization of the chapter. He then read letters and telegrams from the Past Presidents who were unable to attend the meeting, and presented Past Presidents' pins to the nine who were present. Following the presentation of the pins, Mr. Lowe presented the gavel to R. S. Farr, the incoming president, who expressed the appreciation of the chapter for the fine job that Mr. Lowe had done for the chapter and the Society during the past year. Attendance 81.

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SOUTHWEST TEXAS—February 19, 1948. Speaker, C. F. Boester, director of Housing Research, Purdue Research Foundation, Purdue University, Lafayette, Ind., presented Reverse Cycle Refrigeration Combined With Radiant Heating as Applied to Small Homes. Proof of the success of Mr. Boester's talk was the close attention it received and the prolonged discussion which followed. The majority of points covered in the discussion were in connection with the heat pump. Attendance 24.

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SOUTHWEST TEXAS—March 30, 1948. G. R. Rhine, chapter delegate, gave a report regarding his attendance at the Annual Meeting in New York. The Relationship Between the Architect and the Engineer was the title of a very interesting talk by Charles Granger. Additional entertainment was provided during the dinner hour by a male trio. Attendance 25.

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WESTERN MICHIGAN—May 27, 1948. After a talk by T. O. Stafford, the

old officers were retired and H. D. Bratt presided over the installation of the newly elected officers, who are: *President*—H. W. Wolters; *Vice President*—J. L. Alexander; *Secretary*—C. V. Saunders; *Treasurer*—H. D. Burtis; *Board of Governors*—Frank Harbin, Jr., L. A. Calcaterra, E. C. Fox. Each new officer was given a portion of the constitution dealing with the respective office that he is to fill. A bronze plaque, expressing the appreciation of the Michigan Chapter for his services during the past year, was presented to Past President Harbin by Prof. C. H. Pesterfield. R. W. Mangrum reported on the afternoon golf tournament. The championship cup and four balls went to J. T. Reider; and P. D. Winchester, winner of the horseshoe pitching contest, was given a fine set of horseshoes. A set of instructions on how to play horseshoes was presented to President Wolters, in order that he may be able to do better next year. There being no further business for the evening, the meeting was turned over to Mr. Frans, a local businessman, owner of the Holland Electrical Supply Co., and traveler. Mr. Frans showed some most unusual colored motion pictures of Mexico, which he described himself. Attendance 65. Attendance ratio 0.82.

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WESTERN NEW YORK—March 8, 1948. The problem of the mechanical system for the Veteran's Hospital was thoroughly covered at this meeting. First, M. C. Beman, partner, Beman and Candee, Buffalo, N. Y., spoke on the design phase. Joseph Davis, heating engineer and contractor, Buffalo, N. Y., followed with an explanation of the job from the contractor's point of view, and Lee Hopkins gave a resumé of the job from both the design and contracting viewpoints. These talks were found interesting and informative by the members. A joint meeting of the Toronto and Western New York Chapters was announced by F. J. Weber, to be held on April 5 at the General Brock Hotel, Ontario. J. M. Quackenbush reported that a total of $654.00 had been contributed toward the Research Mortgage Retirement Fund. Attendance 57. Attendance ratio 0.82.

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WISCONSIN—May 11, 1948. This meeting, which is called by the chapter the Four Star Final, featured the annual Ladies' Night, National President's Night, Past Presidents' Night, and the Annual Meeting. Pres. J. R. Vernon opened the meeting with a welcome to the ladies. He then welcomed all past presidents who were in attendance, and stated that, of the 24 past presidents of the chapter, 23 are still living and all but four are still in Milwaukee, most of them affiliated with the Wisconsin Chapter. Because of manufacturing difficulties, past presidents' emblems could not be presented, but these will be mailed as soon as possible. Gavels were presented to those past presidents who had not received them. In his talk on Professional Air Control—1960, the President of the Society, G. L. Tuve, Cleveland, Ohio, outlined progress made in the upgrading of engineering qualifications in our industry, as well as in other industries, from both an economic and an educational standpoint, to the advantage of the individual as well as the public. He also discussed research projects conducted by our Society and stressed the continued need for research work in air distribution and automatic control. The annual meeting followed President Tuve's talk. Committee reports were presented, and the result of the election was announced as follows: *President*—W. A. Ouweneel; *Vice President*—W. H. Stevens; *Treasurer*—B. M. Kluge; *Secretary*—H. F. Brinen; *Board of Governors*—J. R. Vernon, O. A. Trostel, and Ernest Szekely. The meeting was closed with a rising vote of thanks to the speaker. Attendance 72.

STUDENT BRANCHES

NORTH CAROLINA—June 1, 1948. The highlight of the evening was Prof. L. L. Vaughan's talk entitled, The Proposed Changes in the Mechanical Engineering Curriculum and the Effect of These Changes on the Heating and Air Conditioning Option as Offered at Present. Professor Vaughan commented briefly on the present emphasis in engineering education on a broader humanitarian background. With this in mind, he reported that the North Carolina State College Engineering Program Committee has tentatively decided to increase the number of cultural courses, but to lower the number of hours required for a Bachelor's Degree. To do this, he stated, it will be necessary to eliminate the heating and air conditioning and aeronautical options that are available in the undergraduate school. Professor Vaughan stated that, though he was a member of the committee that drafted these changes, he did not approve of them. He felt that the present heating and air conditioning program should be expanded rather than curtailed. At the conclusion of his talk, Professor Vaughan introduced the new branch officers: *President*—J. G. Marshall; *Vice President*—H. L. Arey; *Treasurer*—Von Autry, Jr.; *Reporter*—R. F. Bean; *Secretary*—Basil Greene.

A motion was made and carried that the North Carolina Student Branch exert every effort to have the proposed changes in the Mechanical Engineering Curriculum modified, or eliminated. P. St. John Moore, chairman of the publicity committee, reported that his committee is making arrangements for a joint October meeting in Raleigh, N. C., with the North Carolina Chapter of the Society and the Student Branch. Attendance 26.

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TEXAS A & M—May 20, 1948. Pres. S. E. Ammons read a letter sent to National Headquarters and the two

newly organized student branches, which recommended that the constitution and by-laws of the ASHVE concerning chapter delegates be amended to include chapter delegates of the student branches. If this amendment is approved, each student chapter will send a delegate to the Society meetings. The president also stated that letters of congratulations had been sent to the two new student branches at Purdue and North Carolina. Because the joint meeting, held on May 11, was such a success, it was voted to make the joint meeting an annual affair. Officers for the coming fall semester will be: *President*—S. E. Ammons; *Vice President*—T. V. Burns; *Secretary-Treasurer*—C. P. Howard. Owing to the increased activities and business in the chapter, the office of parliamentarian was created, to facilitate the job of the president. J. G. Blum was elected parliamentarian. Attendance 19.

TEXAS A & M—May 11, 1948. This was a joint meeting of the Texas Chapters, and no business was conducted. Guest speaker, R. F. Taylor, consulting engineer, Houston, Tex., gave an informative and entertaining talk on the history of the ASHVE, and the advantages that are offered to its members. Part of Mr. Taylor's talk was devoted to the organization of the Research Foundation and its past, present and future work. Other honored guests were, D. M. Mills, president of the South Texas Chapter, and B. S. Foss, Jr., president of the North Texas Chapter. Both these men gave brief talks in which they invited the student members to attend their respective chapter meetings whenever possible. President Ammons expressed the thanks of the student branch for the assistance and guidance given them by the senior chapters, and stated that he anticipated even greater achievements during the coming year. Attendance 45.

TEXAS A & M—May 6, 1948. Summer employment was brought up for consideration at this meeting. L. W. Thompson, Jr., of the placement committee, reported that notice of job openings for summer employment had been received from Houston and Fort Worth, but that as yet no information was available as to placement in Dallas or San Antonio. Mr. Manget said that there were openings for permanent employment in Fort Worth. Pres. S. E. Ammons announced that final plans for the joint meeting of the Texas Chapters of ASHVE had been made, and he urged the attendance of all members. Final arrangements were made for Engineers' Day by R. F. Phillips, who appointed members to assist in getting equipment prepared for display at the exhibit. Attendance 24. Attendance ratio 0.55.

Purdue Student Branch Officers Receive Minute Book

(left to right) J. H. Miller, D. E. Blue, A. V. Hutchinson, F. B. Morse, W. T. Miller, R. G. James, D. M. Long, B. E. Petry

DAVID L. FISKE OPENS CONSULTING OFFICE

David L. Fiske, New York, N. Y., has announced the opening of his consulting engineering office, at 111 Broadway, New York, N. Y., specializing in refrigerating, ultra-low temperatures, quick freezing, food preservation, air conditioning, and insulation. Mr. Fiske received his B.S. in Mechanical Engineering at the Massachusetts Institute of Technology, his M.S. in Thermodynamics at the University of Illinois and his Ph.D. in Industrial Engineering at Columbia University. He has published articles on various phases of refrigeration and was the editor of seven editions of the Refrigerating Data Book, as well as secretary of *ASRE*.

J. T. LANG, CONSULTANT

Jorge T. Lang, former head of the Air Conditioning and Commercial Refrigerating Department, A.S.S.A. Ltda. S.A.I., Buenos Aires, Argentina, S.A., has recently announced the opening of his own consulting engineering offices, which are located in that city. His firm will specialize in heating, refrigerating and air conditioning projects. Mr. Lang has been a member of the Society since 1946, and is also a member of *ASRE*.

M. K. RUSH APPOINTED SALES REPRESENTATIVE

American Air Filter Co., Inc., Louisville, Ky., has recently announced the appointment of Merle K. Rush as sales representative in Omaha, Nebr. Prior to forming the Rush Co., Mr. Rush was connected with Hucker Sales Co., Philadelphia representative of American Air Filter.

M. K. Rush

Candidates for Membership

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When the replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 85 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by August 25, 1948, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

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IOWA	C. A. Wheeler	D. C. Murphy
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ASHVE Research Laboratory, 7218 Euclid Ave., Cleveland 3, Ohio (Tel.: EXpress 6161)

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Panel Heating and Cooling: G. D. Winans, *Chairman;* A. B. Algren*, R. L. Byers, P. B. Gordon, L. N. Hunter* *(Ex-Officio)*, John James*, J. S. Locke, John Magos, H. F. Randolph, Cyril Tasker *(Ex-Officio).*

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Group B—Heat Transfer Between the Panel and the Space: John James*, *Chairman;* H. F. Randolph, *Vice Chairman;* C. M. Ashley, J. T. Bergen, C. F. Boester, Wharton Clay, Linn Helander, A. L. Jaros, Jr., H. A. Lockhart, C. O. Mackey*, R. A. Miller, G. W. Penney, G. G. Sward, J. M. van Nieukerken.

Group D—Controls: J. S. Locke, *Chairman;* A. B. Algren*, H. W. Alyea, S. D. Browne, R. L. Campbell, C. M. Garner, P. B. Gordon, W. J. Hajek, A. J. Keating, W. H. Klievер, H. T. Kucera, P. F. Neess, R. S. Penn, J. K. M. Pryke, E. J. Ritchie, C. W. Signor, N. D. Skinner, A. S. Widdowfield.

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Sorbents: John Everetts, Jr., *Chairman;* F. C. Dehler, M. C. Giannini*, C. H. B. Hotchkiss, E. R. McLaughlin, J. C. Patterson, G. L. Simpson, F. J. Swaney.

Weather Design Conditions: T. H. Urdahl*, *Chairman;* J. C. Albright, P. D. Bemis, H. S. Birkett, J. P. Fitzsimons, J. H. Hart, W. L. Holladay, W. M. Wallace, II.

*Member of Committee on Research.

OFFICERS OF LOCAL CHAPTERS AND STUDENT BRANCHES

(40 Chapters—3 Student Branches)

Atlanta: Organized, 1937. Headquarters, Atlanta, Ga. Meets, First Friday. President, L. L. Barnes, 3865 Wieuca Terrace. Secretary, R. L. Beach, 131 Clarion Ave., Decatur.

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Central New York: Organized 1944. Headquarters, Syracuse, N. Y. President, D. L. Mills, 1407 N. Madison St., Rome. Secretary, J. H. Carpenter, 3515 Midland Ave., Syracuse 7.

Central Ohio: Organized, 1944. Headquarters, Columbus, Ohio. Meets, Third Monday. President, W. M. Myler, Jr., P.O. Box 267, Columbus 16. Secretary, H. G. Hays, 851 W. Third Ave., Columbus 8.

Cincinnati: Organized 1932. Headquarters, Cincinnati, Ohio. Meets First Tuesday. President, H. K. Jennings, 1639 Union Trust Bldg., Cincinnati 2. Secretary, K. B. Little, 832 Temple Bar Bldg., Cincinnati 2.

Connecticut: Organized, 1940. Headquarters, New Haven, Conn. President, E. C. Marsden, 44 Hicks St., Hartford. Secretary, T. L. Arnold, 26 Francis Ave., Hartford.

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Delta: Organized, 1939. Headquarters, New Orleans, La. Meets, Second Tuesday. President, L. V. Busenlener, 2927 Jackson Ave., New Orleans 13. Secretary, Ralph Elizardi, 314½ St. Charles Ave., New Orleans 12.

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Golden Gate: Organized, 1937. Headquarters, San Francisco, Calif. Meets, First Thursday. President H. V. Hickman, 1129 Folsom St., San Francisco 1. Secretary, R. C. Cushing, 1136 Howard St., San Francisco 3.

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Illinois: Organized, 1906. Headquarters, Chicago, Ill. Meets, Second Monday. President, C. M. Burnam, Jr., 6 N. Michigan Ave., Chicago 2. Secretary, G. W. Bornquist, 629 W. Washington Blvd., Chicago 6.

Indiana: Organized, 1943. Headquarters, Indianapolis, Ind. Meets, Fourth Friday. President, P. R. Jordan, 311 E. South St., Indianapolis 4. Secretary, C. F. A. Locke, 1007 N. Meridian St., Indianapolis 4.

Iowa: Organized, 1940. Headquarters, Des Moines, Ia. Meets, Second Tuesday. President, D. C. Murphy, 840 Fifth Ave., Des Moines 14. Secretary, R. S. Stover, Kresge Bldg., Marshalltown.

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Kansas City: Organized, 1917. Headquarters, Kansas City, Mo. Meets First Monday. President, H. E. Gould, 1924 Oak Rd., Kansas City 8. Secretary, K. M. Stevens, 1510 Main St., Kansas City.

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Manitoba: Organized, 1935. Headquarters, Winnipeg, Man., Canada. Meets, Second Thursday. President, J. R. Stephenson, 278 Main St., Winnipeg. Secretary, D. F. Michie, 278 Main St., Winnipeg.

Massachusetts: Organized, 1912. Headquarters, Boston, Mass. Meets, Third Tuesday. President, R. T. Kern, 51 Claflin St., Leominster. Secretary, D. W. Blair, 59 Frost St., Cambridge.

Memphis: Organized, 1944. Headquarters, Memphis, Tenn. Meets, First Monday. President, E. E. Scott, 918 Dermon Bldg., Memphis 3. Secretary, A. T. Bevil, 1521 Waverly Ave., Memphis 6.

Michigan: Organized, 1916. Headquarters, Detroit, Mich. Meets, First Monday after 10th of month. President, E. F. Hyde, 708 Oakland Ave., Birmingham. Secretary, J. H. Spurgeon, 5050 Joy Rd., Detroit 4.

Minnesota: Organized, 1918. Headquarters, Minneapolis, Minn. Meets, First Monday. President, O. L. Lilja, 5000 16th Ave., S., Minneapolis 7. Secretary, E. F. Snyder, Jr., 4324 Zenith Ave., N., Minneapolis 12.

Montreal: Organized, 1936. Headquarters, Montreal, Que., Canada. Meets, Third Monday. President, Leo Garneau, 25 Salisbury Rd., Pointe Claire, Que. Secretary, R. R. Noyes, 630 Dorchester St. W., Montreal.

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Nebraska: Organized, 1940. Headquarters, Omaha, Neb. Meets, Second Tuesday. President, K. R. Magarrell, 127 So. Main St., Council Bluffs, Ia. Secretary, F. E. Prawl, 308 So. 15th St., Omaha 2.

New York: Organized, 1911. Headquarters, New York, N. Y. Meets, Third Monday. President, A. A. Bearman, 444 West 56th St., New York 19. Secretary, Carl H. Flink, Room 3000, 51 Madison Ave., New York 10.

North Carolina: Organized, 1939. Headquarters, Durham, N. C. Meets, Quarterly. President, E. S. deWitt, 1211 Commercial Bank Bldg., Charlotte. Secretary, R. M. Warren, Jr., 1001 N. Church St., Charlotte 1.

North Texas: Organized, 1938. Headquarters, Dallas, Tex. Meets, Third Monday. President, B. S. Foss, Jr., 711 Construction Bldg., Dallas 1. Secretary, Herman Blum, Jr., 2812 Fairmount St., Dallas 4.

Northern Ohio: Organized, 1916. Headquarters, Cleveland, Ohio. Meets, Second Monday. President, W. R. Moore, 5005 Euclid Ave., Cleveland. Secretary, John Richmond, 10210 Woodland Ave., Cleveland 4.

Oklahoma: Organized, 1935. Headquarters, Oklahoma City, Okla. Meets, Second Monday. President, J. H. Spaan, Jr., 1303 N. Klein, Oklahoma City 6. Secretary, J. R. Patten, 627 N.W. Second St., Oklahoma City.

Ontario: Organized. 1922. Headquarters, Toronto, Ont., Canada. Meets, First Monday. President, E. G. Spall, 73 Simcoe St., Toronto 1. Secretary, H. R. Roth, 57 Bloor St., W., Toronto, Ont.

Oregon: Organized, 1939. Headquarters, Portland, Ore. Meets, Thursday after First Tuesday. President, E. R. Lokey, 1238 N. W. Glisan St., Portland 9. Secretary, A. N. Hoss, 621 S. W. Alder, Portland.

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Pacific Northwest: Organized, 1928. Headquarters, Seattle, Wash. Meets, Second Tuesday. President, L. L. Bysom, 1214 Eighth St., Bremerton. Secretary, D. O. Mead, 816 Arctic Bldg., Seattle 4.

Philadelphia: Organized, 1916 Headquarters, Philadelphia, Pa. Meets, Second Thursday. President, J. O. Kirkbride, Fourth & Locust Sts., Philadelphia 6. Secretary, M. E. Barnard, 12 S. 12th St., Philadelphia 7.

Pittsburgh: Organized, 1919. Headquarters, Pittsburgh, Pa. Meets, Second Monday. President, H. E. Park, 201 E. Carson St., Pittsburgh 19. Secretary, E. H. Riesmeyer, Jr., 231-33 Water St., Pittsburgh 22.

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Rocky Mountain: Organized, 1944. Headquarters, Denver, Colo. Meets, First Wednesday. President, Fred Janssen, 1123 W. Third Ave., Denver 9. Secretary, F. C. Allen, 4467 King St., Denver 11.

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St. Louis: Organized, 1918. Headquarters, St. Louis, Mo. Meets, First Tuesday. President, B. L. Evans, 571 Stratford Ave., University City. Secretary, C. H. Burnap, 1635 Syndicate Trust Bldg., St. Louis 1.

Shreveport: Organized 1948. Headquarters, Shreveport, La. President, W. E. FitzGerald, 939 Louisiana Ave., Shreveport. Secretary, O. J. Dykes, Jr., 1012 Market St., Shreveport.

South Texas: Organized, 1938. Headquarters, Houston, Tex. Meets, Third Friday. President, C. C. Quin, 809 Stuart Ave., Houston 6. Secretary, R. J. Salinger, 4510 Dewberry Lane, Houston 4.

Southern California: Organized, 1930. Headquarters, Los Angeles, Calif. Meets, Third Wednesday. President, R. S. Farr, 2615 Southwest Dr., Los Angeles. Secretary, L. J. Helms, 633 S. Berendo St., Los Angeles 5.

Southwest Texas: Organized, 1946. Headquarters, San Antonio, Tex. President, G. R. Rhine, 1208 Alamo National Bldg., San Antonio. Secretary, I. W. Wilke, 422 Congress Ave., Austin.

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Utah: Organized, 1944. Headquarters, Salt Lake City, Utah. Meets, First Wednesday. President, E. V. Gritton, 2470 S. 15th, Salt Lake City 5. Secretary, C. E. Ferguson, 838 Garfield Ave., Salt Lake City.

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Virginia: Organized, 1946. Headquarters, Norfolk, Va. Acting President, J. E. White, 7607 Gloucester Ave., Norfolk 5. Secretary, D. E. Phillips, P. O. Box 674, Newport News.

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Washington, D. C.: Organized, 1935. Headquarters, Washington, D. C. Meets, Second Wednesday. President, A. S. Gates, Jr., 621 N. Jackson St., Arlington, Va. Secretary, J. G. Muirheid, 2013 New Hampshire Ave., N. W., Washington 9.

Western Michigan: Organized, 1931. Headquarters, Grand Rapids, Mich. Meets, Second Monday. President, H. W. Wolters, 820 Staples Ave., N.W., Kalamazoo 54. Secretary, C. V. Saunders, P. O. Box 671, Kalamazoo 99.

Western New York: Organized, 1919. Headquarters, Buffalo, N. Y. Meets, Second Monday. President, Edwin Woolcock, 2217 15th St., Niagara Falls, N. Y. Secretary, T. F. Killeen, 374 Delaware Ave., Buffalo 2.

Wisconsin: Organized, 1922. Headquarters, Milwaukee, Wis. Meets, Third Monday. President, W. A. Ouweneel, 514 E. Ogden Ave., Milwaukee 2. Secretary, H. F. Brinen, 2226 Kinzie Ave., Racine.

Student Branches

North Carolina State College: Organized 1948. Headquarters, Raleigh, N. C. President, J. G. Marshall, North Carolina State College. Secretary, Basil Greene, Apt. D-2, Grosvenor Garden Apts., Raleigh.

Purdue University: Organized 1948, Headquarters, W. Lafayette, Ind. Chairman, R. G. James, 411 E. 37th St., Indianapolis. Secretary, D. M. Long, FPHA Apt. 423-2, W. Lafayette.

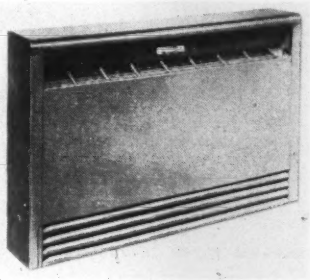
Texas A. & M. College: Organized, 1946. Headquarters, College Station, Tex. Meets, Third Thursday. President, S. E. Ammons, 212 13th Ave., No., Texas City. Secretary, C. P. Howard, Box 1706, College Station.

EQUIPMENT DEVELOPMENTS

For your convenience in obtaining more information about any of this equipment, see coupon on this page. Add the new products and companies listed here to your Directory Section which you received in your January 1948 Heating, Piping & Air Conditioning and thus keep your records of sources of supply up to date throughout the year. Single asterisk indicates equipment not listed in Directory Section; double asterisk equipment and manufacturer not listed.

New Appearance, Features in Line of Convectors

No. 3822 — A new line of convector-radiators, said to incorporate many new appearance, installation, and operating features, has been been developed by Modine Mfg. Co., Racine, Wis.



Curved outlet air grilles are located within the enclosure so that when the control damper is closed, it conceals the outlet grille. Louvered inlet grilles snap in and out of place and may be added at a later date. According to the company, the front panel is easily removable in a matter of seconds. Performance ratings have been determined in accordance with the new commercial standard for testing and rating convectors.

Four enclosure styles are available in the standard line; three in the heavy duty institutional line.

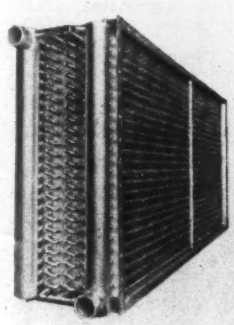
Wrench Has Eccentric and Reversible Jaw

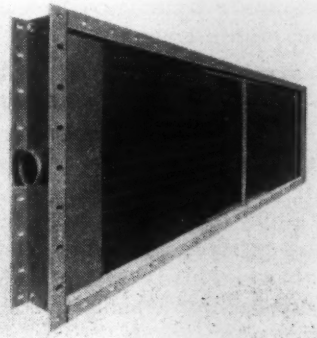
No. 3823*—The new "Red-E-Basin" wrench is said to speed and simplify the work of applying and removing inaccessible fittings. Made by the American Die & Tool Co., Second & Buttonwood Sts., Reading, Pa., the new wrench is designed to aid the construction and maintenance of piping and has an eccentric, reversible jaw.

According to the manufacturer, it is a durable, quality tool that will serve for years.

Redesigned Heating, Cooling Coils Have Plate Type Fins

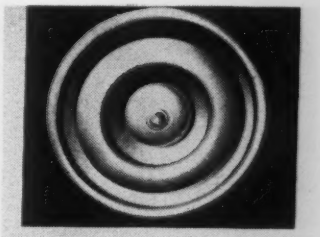
No. 3824—McQuay, Inc., 1600 Broadway, N.E., Minneapolis 13, Minn., has completely redesigned its line of nonferrous, extended surface heating and cooling coils.

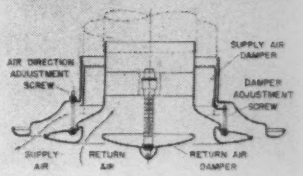




The coils incorporate the new plate type "Ripple Fin" construction and also feature "Ripple Tubes." According to the company, stronger and more versatile casings are now used. Other features are said to include intruded tube holes, spun fin collars, turned back channel casings, matching bolt holes in the casings, and elliptically shaped headers. In the illustration, a cooling coil is shown at the left and a heating coil at the right.

Air Diffuser Handles Supply and Exhaust Air





No. 3825—A recent addition to the "Kno-Draft" line of adjustable air diffusers, offered by W. B. Connor Engineering Corp., 114 E. 32nd St., New York 16, N. Y., is intended for use where air is to be both discharged from and returned or exhausted through a common unit. The supply air is discharged from between the outer and intermediate cones and the return or exhaust air is drawn through the center section of the diffuser.

According to the company, it is so designed that the supply air is ejected away from the return air opening so as to eliminate any short circuiting of supply air into the return air opening. Supply air volume is controlled by a cylindrical, sliding, sleeve type damper fitted to the inside of the diffuser neck and connected by means of peripheral operating screws to the intermediate cone.

Variation of air direction is accomplished by raising or lowering the inner assembly. To reduce the downward discharge angle or produce a more horizontal direction of air discharge, the inner assembly is lowered. The center cone constitutes the return air damper which is adjusted by rotating on a central operating screw.

Heating, Piping & Air Conditioning **[8-48]**
6 N. Michigan Ave., Chicago 2, Ill.

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(Circle each number in which you are interested)

3822 3823 3824 3825 3826 3827 3828 3829 3830 3831
3832 3833 3834 3835 3836 3837 3838 3839 3840 3841
3842 3843 3844 3845 3846 3847 3848 3849 3850 3851
3852
6917 6918 6919 6920 6921 6922 6923 6924 6925 6926
6927 6928 6929 6930 6931 6932 6933 6934 6935 6936
6937 6938 6939 6940 6941 6942 6943 6944 6945 6946
6947 6948 6949 6950 6951 6952 6953 6954 6955 6956
6957 6958 6959 6960

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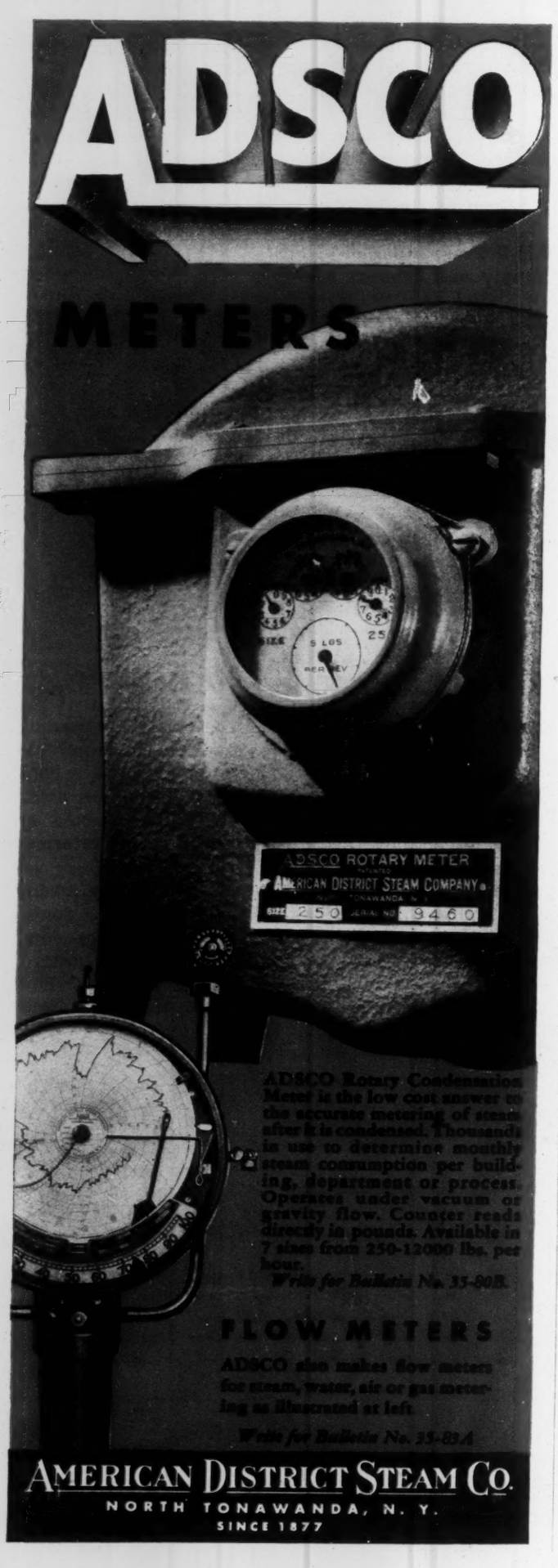
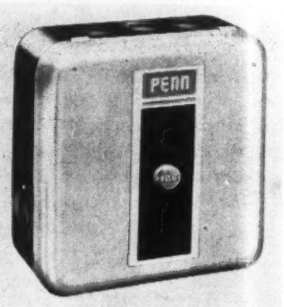
Address .....

City ..... **Zone** ..... **State** .....


ADSCO
METERS
ADSCO ROTARY METER
AMERICAN DISTRICT STEAM COMPANY
SIZE 250 SERIAL NO 9460
ADSCO Rotary Condensation Meter is the low cost answer to the accurate metering of steam after it is condensed. Thousands in use to determine monthly steam consumption per building, department or process. Operates under vacuum or gravity flow. Counter reads directly in pounds. Available in 7 sizes from 250-12000 lbs. per hour.
Write for Bulletin No. 35-80B
FLOW METERS
ADSCO also makes flow meters for steam, water, air or gas metering as illustrated at left.
Write for Bulletin No. 35-89A
AMERICAN DISTRICT STEAM CO.
NORTH TONAWANDA, N. Y.
SINCE 1877

Motor Starters Have Adjustable Manual or Automatic Overload Relay



No. 3826—A new line of magnetic motor starters and contactors in sizes 0, 1, and 1½ has been developed by Penn Electric Switch Co., Goshen, Ind. These units are supplied with NEMA type 1 general purpose enclosures but are also available without enclosure for control panel application.

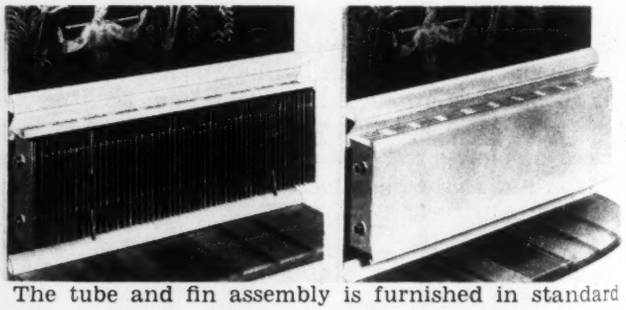
Size 0 and 1 starters and contactors are built in two, three, and four pole construction with normally open interlocks. For single phase motors of higher rating, the size 1 four pole device is reconnected with two pairs of poles in parallel to form a two pole starter. In this form it is designated as size 1½.

Among the advantages incorporated into this line, says the manufacturer, is the overload relay which is adjustable for manual and for automatic reset.

Baseboard Heating Unit Has Copper Tubing, Aluminum Fins

No. 3827*—A baseboard heating unit, said to have a capacity of 600 Btu per hr per lineal foot with 170 F forced water, has been announced by Rittling Corp., 1292 Niagara St., Buffalo 13, N. Y.

The heating core is of continuous copper tubing with aluminum fins and the entire unit is covered by a decorative heavy gage sheet steel, grilled warm air outlet and deflector. According to the manufacturer, heating units approximate the depth of (and can be used in place of) present baseboards because they do not require recessing and can be installed either before or after floors are laid.



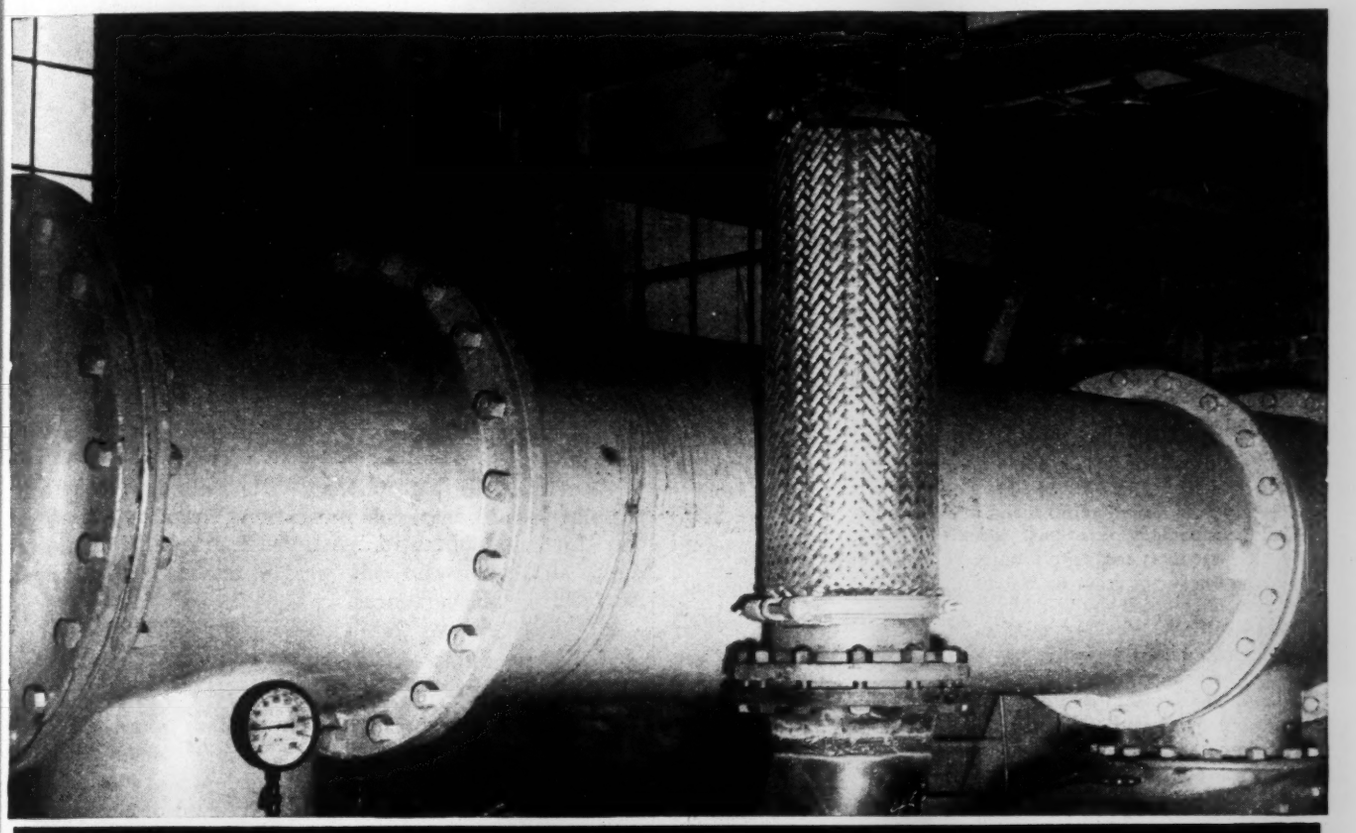
The tube and fin assembly is furnished in standard lengths of 2, 3, 5 and 9 ft and can be joined by sweat fittings or compression fittings. Manifolds are supplied for each end of standard lengths. The front metal cover is supplied in 6 ft lengths which can be cut as required. Units may be connected to either steam or hot water boilers.

Complete Refrigerating Unit Sealed in Room Conditioner

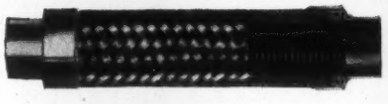
No. 3828*—A hermetically sealed operating unit is now featured in the "Yorkaire" window sill type, room air conditioners offered by York Corp., York, Pa.

Chief feature of the design is the complete sealing of the refrigerating unit (not just the compressor and motor). This is said to make the conditioner both tamperproof and trouble free so that a five year guarantee is offered.

Isolate compressor vibration



with REX *Super-Service* VIBRA-SORBERS



REX VIBRA-SORBERS are scientifically corrugated flexible hose with bronze braid. They are available in bronze or steel with straight extended tube ends or with threaded fittings. Special units with bent extended tube ends for angle installations are also available.

In refrigeration or air conditioning systems . . . in connecting lines of pumps, turbines and allied equipment . . . wherever it is necessary or desirable to prevent transmission of vibration or noise into rigid piping, Rex Super-Service Vibra-Sorbers offer dependable control. Leak-tight and fatigue-resistant Vibra-Sorbers reduce piping maintenance and assure minimum noise transmission.

"FLEXON" Identifies CMH Products, which have served industry for more than 45 years.

"the science of FLEXONICS . . ." the controlled bending of thin metals for use under varying conditions of temperature, pressure, vibration and corrosion" . . . is exemplified in the basic products of Chicago Metal Hose Corporation.

Write for data sheets giving detailed information on Rex Vibra-Sorbers . . . it's the first step toward vibration control.

CMH **FLEXIBLE METAL HOSE**

CHICAGO METAL HOSE CORPORATION

Maywood, Illinois

Plants at Maywood, Elgin and Rock Falls, Illinois

BOILER-BURNER UNITS

ALDRICH HEAT-PAK PRODUCTS

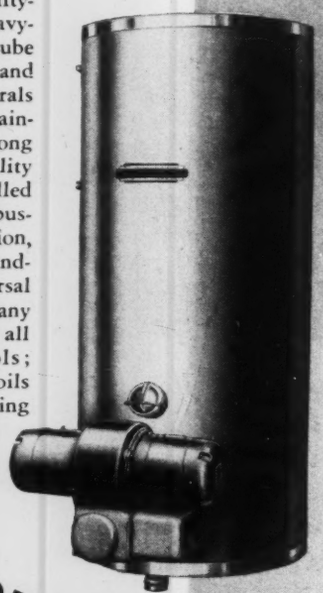
in

6 Sizes

FOR DOMESTIC, COMMERCIAL AND INDUSTRIAL USE

- **HOT WATER HEATING**
- **STEAM HEATING**
- **HOT WATER SUPPLY**

Here is a line of Boiler-Burner Units that will take care of practically any requirement — from a small water heater for a residence to a heating installation in an industrial plant, and including many processing applications. A dealer offering Aldrich products can supply units with any capacity from 85,000 to 808,500 BTU per hour. Aldrich Boiler-Burner Units are quality-built throughout — extra-heavy-gauge steel, vertical, fire-tube boilers, accurately welded and thoroughly tested; built-in spirals that reduce sooting and help maintain maximum efficiency for long periods; matched, high-quality Aldrich Burners, factory-installed and wired, complete with combustion chamber, thick insulation, properly installed under a handsome sheet-metal shell; universal tapping, fitting any model for any service; suitable gauges, and all necessary automatic controls; spiral copper water-heating coils in specified models of heating boilers. With all these quality features to offer at competitive prices, any Aldrich dealer should do *good business.*



ALDRICH OIL BURNERS

The widely-favored, skilfully-engineered, dependable Aldrich Burners are made in 3 types and 5 models with capacities ranging from .75 to 19 gph — a range sufficient to handle practically any oil-burning demand.

ALDRICH COMPANY

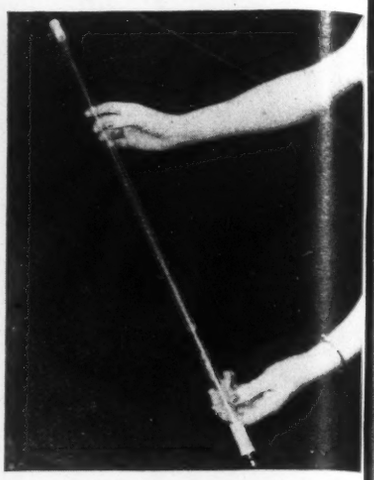
WRITE TODAY FOR COMPLETE DATA AND PRICE LISTS . . .

OIL BURNERS • BOILER BURNERS FOR HEATING AND DOMESTIC WATER SUPPLY

105 EAST WILLIAMS ST., WYOMING, ILL.

Powered by a ¾ hp motor, the unit incorporates a corrugated fin and staggered tube cooling coil and an improved seven-ply air filter.

Claims High Ultraviolet Output for Germicidal Lamp



No. 3829—A 25 watt "Slimline Sterilamp" which is said to emit more than twice as much ultraviolet radiation as any lamp heretofore on the market, has been developed by Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa. The lamp, 36 in. long, supplements the company's standard line of hot and cold cathode units.

Electrical characteristics of the unit are said to be similar to the company's fluorescent lamp. It is designed for starterless operation with the firm's 64T6 fluorescent lamp auxiliaries and will operate, in any position, down to freezing temperatures.

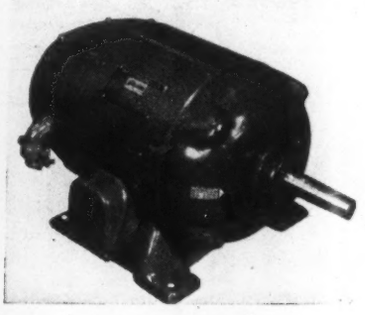
Axial Flow Pump Designed to Resist Corrosion

No. 3830—A large capacity axial flow pump, designed to resist contaminated sea water and other corrosive liquids, has been announced by Economy Pumps, Inc., Hamilton, Ohio. The new pumps are said to be especially suited to condenser circulation and other services requiring low cost high speed pumping of large volumes of liquids.

Impellers and suction bells are cast of 25 percent chrome-12 percent nickel stainless steel. Pump shafts are 18-8 stainless. Column and discharge elbows are formed of cast iron containing approximately 2 percent nickel.

According to the company, these axial flow pumps are best fitted for applications where any variation in head is a reduction, and where the resultant increase in capacity is not objectionable. Because of individual problems attending their application most units are custom built for specific jobs.

Uses Fabricated Steel Construction in Line of Dripproof Induction Motors



No. 3831 — A new wound rotor, "Life-Line" induction motor of open dripproof construction is available from Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa., in ratings of 1 to 15 hp (frames 203 through 326).

The frame is rolled

One of a series of messages to help you increase your understanding of business paper advertising, and its effect on your business.

How much longer can your company afford to "refuse business tactfully"?

LET'S FACE IT — the honeymoon is about over. It was fun while it lasted, but it won't pay the rent. Not now.

After an absence of seven years, the spectre of a buyers' market is once more rearing its head, and its expression plainly reads—"I'm going to be hard to get."

This doesn't scare anybody who hasn't forgotten *how to sell.* But there are quite a few of us in American business who could use a quick refresher course. (We've had a long "vacation.")

When it comes to production, our output is up almost 100 per cent. We've acquired a lot of new techniques on the assembly line, because it was obvious that if there were to be any profits left—after increased labor costs, high-priced materials, and taxes—we'd have to trim every last ounce of fat off the manufacturing cost per unit.

But now the time has come when we must apply the same philosophy to the *manufacture of a sale.* That means—*more mechanization!*

Confronted with a buyers' market, how much will it cost *your* company to produce one unit of sale? A prohibitive sum, if you're going to depend entirely on personal contact. You'd have to hire a tremendous force of salesmen to cover the field. Even then, much of their valuable time would be spent on "missionary work"—which is really a job for *mechanized selling.*

Mechanized selling is simply another name for consistent and aggressive advertising. Like the machine on the production line, it is a multiplier of men's efforts, for it enables them to produce *(and earn)* far more than they could alone.

And when it goes to work in the business press, it becomes the most efficient machine at your disposal for *manufacturing sales at a profit!*

Just how efficiently does business paper advertising work? If you'd like to see some examples, we'll be glad to send you a recent ABP folder on actual results. Also, if you'd like reprints of this advertisement (or the entire series) to show to others in your organization, you may have them for the asking.

Heating Piping & Air Conditioning

is one of the 129 members of The Associated Business Papers, whose chief purpose is to maintain the highest standards of editorial helpfulness—for the benefit of reader and advertiser alike.

FOR

Quality Products
Prompt Service
Profitable Cooperation

E. G. Carpenter, President
Careva Company, York, Pa.

Buy from a Herman Nelson Distributor like Careva Company of York, Pennsylvania.

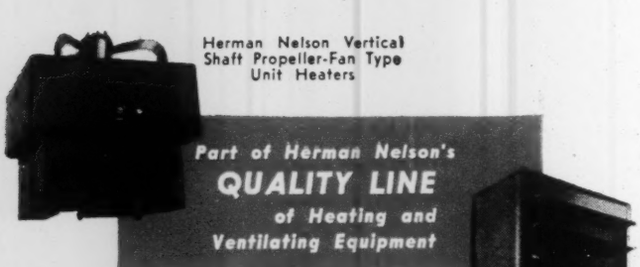
The Herman Nelson Corporation and its carefully selected Distributors like Careva Company have a nationwide reputation for prompt delivery of quality products. What's just as important — they're ready and anxious to help you with profitable merchandising cooperation.

Sales promotion campaigns and literature provided by Herman Nelson are boosting sales for dealers and contractors throughout the country.

Herman Nelson distributors meet your requirements promptly from stock for both equipment and installation materials.

Immediate service from Herman Nelson is available from members of the sales and engineering departments of its distributor organizations.

Increase your business by selling Herman Nelson quality products and benefit from prompt service and friendly cooperation. Contact the nearest Herman Nelson distributor for quality heating and ventilating equipment and the kind of cooperation and service that mean extra profits for your business.

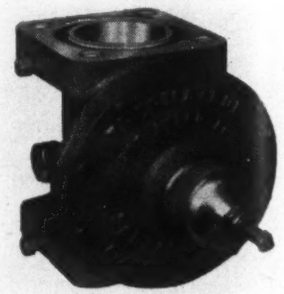

Herman Nelson Vertical Shaft Propeller-Fan Type Unit Heaters
Part of Herman Nelson's
QUALITY LINE
of Heating and Ventilating Equipment
Herman Nelson Horizontal Shaft Propeller-Fan Type Unit Heaters

THE HERMAN NELSON CORPORATION
Since 1906 Manufacturers of Quality Heating and Ventilating Products
MOLINE, ILLINOIS

from steel plate and the feet are pressed steel. The pulley end bracket is pressed steel and the front end bracket is of gray cast iron. The brushes for this motor, type CWP, are made of electro-graphite or metal graphite, depending on service requirements. Brushholders are of the sliding box type with adjustable spring tension.

According to the manufacturer, the motor may be used wherever adjustable speed is required or where high starting torque with low starting current is necessary. Balanced design, quiet operation, and rugged construction are said to make it especially useful for driving compressors, plunger pumps, positive pressure blowers and adjustable speed ventilating fans.

Controls Refrigeration Compressor Capacity



No. 3832 — To maintain even evaporator temperatures in air conditioning installations, Schnacke, Inc., 1016 E. Columbia St., Evansville, Ind., has developed and patented the "Thermatrol" which is also designed to prevent unnecessary cycling and to reduce current consumption in proportion to the load.

The device is an automatically controlled butterfly valve actuated by back pressure, and it regulates the flow of refrigerant pumped by the compressor. Mounted on the suction shutoff valve between the evaporator and the compressor, it operates in conjunction with the thermostatic expansion valve. When the expansion valve opens, more refrigerant is permitted to pass. This increases the back pressure and causes the control to open, thus allowing the compressor to pump its full capacity. As the air that is being cooled by the evaporator decreases in temperature, the evaporator pressure decreases until it corresponds to the setting of the capacity control which then begins to unload the compressor by checking the flow refrigerant to it. A bypass in the unit is used to eliminate the possibility of a complete vacuum condition.

The control unit is applicable to any of the company's compressor and condensing unit models.

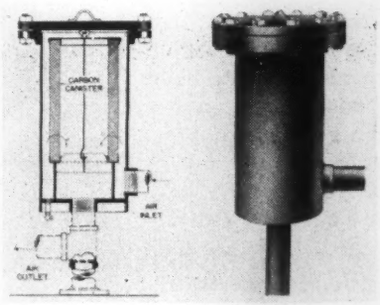
Rubber Panel Used for Electric Radiant Heating

No. 3833—"Uskon" is a natural rubber, developed by United States Rubber Co., 1230 Sixth Ave., New York 20, N. Y., which permits the conduction of electricity. The material, sealed between layers of phenolic impregnated insulation, is available in either 4 x 4 ft or 3 x 4 ft panels approximately ¼ in. thick for use as radiant panel ceiling units.

Operating on 220 volts, the panels are made in two standard wattage densities, 17 and 22 watts per sq ft. They may be connected in groups of parallel circuits and, according to the manufacturer, may be finished with paint, paper, plaster, or fabric.

Operating costs are said to compare favorably with other systems where electricity at 1½ cents per kwhr is available.

Removes Gaseous Impurities from Compressed Air



No. 3834—The compressed air line gas adsorber, one of the "Dorex" line of activated carbon air "purification" units, has recently undergone several modifications and improvements in construction. This unit, type PL, is especially designed to extract vapors, fermentation odors, and other gaseous impurities from compressed air and is said to be the only device which effectively removes air entrained contaminants not eliminated by commercial filters, separators, aftercoolers, or receivers. The manufacturer is W. B. Connor Engineering Corp., 114 E. 32nd St., New York 16, N. Y.

The device, says the company, may be applied to advantage wherever purity of compressed air is essential, such as in pneumatic agitation of foods, medicines, and cosmetics.

The adsorber, which may be located at any point in the line, is housed in a flanged steel shell containing an internal manifold, air inlet, outlet, and drain connection. The activated carbon adsorption medium is said to frequently last several years before requiring replacement.

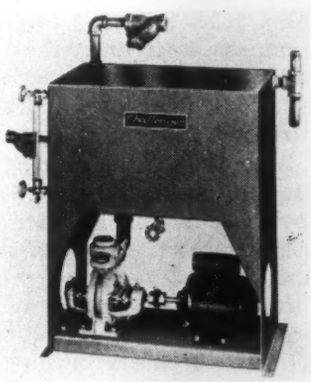
Laminated Cork and Rubber Isolates Vibration

No. 3835—Korfund Co., Inc., 48-15 32nd Pl., Long Island City 1, N. Y., has announced the availability of new and improved "Elasto-Rib," a laminated rubber-cork material for low cost vibration and noise control.

It is composed of a layer of cork bonded between two layers of grooved, synthetic rubber. The ribbed contour of the rubber is designed to increase the isolation properties by providing greater deflection and to form a nonskid contact with the floor, frequently eliminating the need for bolting machines to the floor.

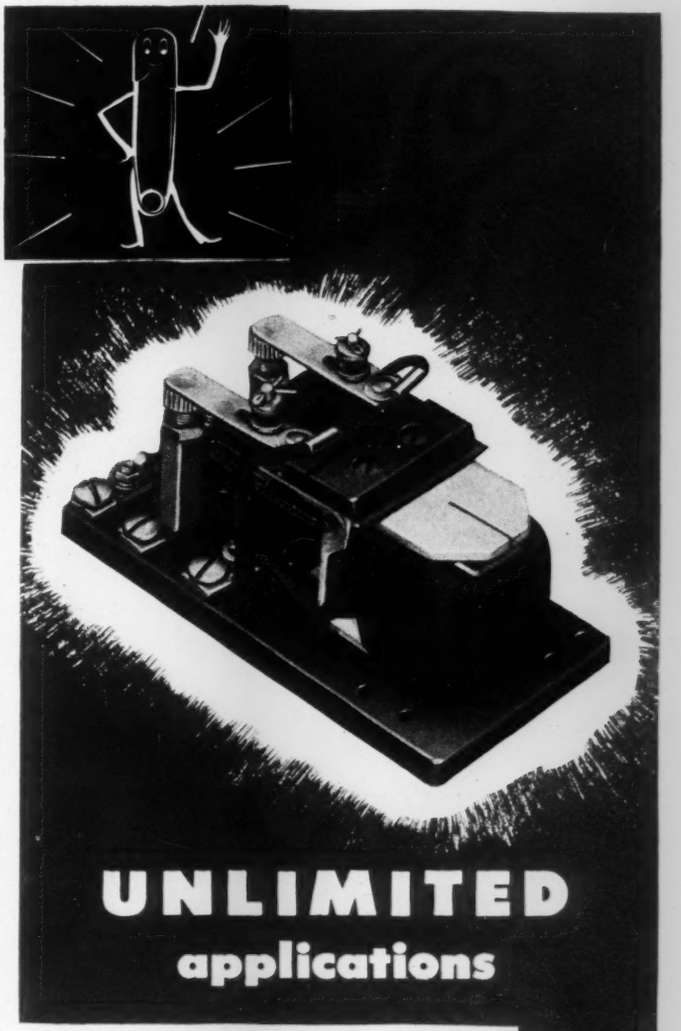
The material is now available in 1 in. thick sheets up to 24 x 36 in. Recommended loading is from 7 to 21 psi.

Packaged Design Used in Boiler Return System



No. 3836—The "Challenger" series of small boiler return systems, designed to give the same quality operating service as the company's regular line, has been developed to meet the demand for a low cost packaged type unit. The manufacturer is Fred H. Schaub Engineering Co., Inc., 2110 S. Marshall Blvd., Chicago 23, Ill.

It is available in three sizes to handle boiler loads up to 50 hp at 100 psi operating pressure and 40 hp at 125 psi.



Ward Leonard 130 Relay easily adapted to a wide variety of requirements

The principle of using one basic construction makes Ward Leonard's 130 Relay both versatile and economical. Merely by the selection of certain interchangeable parts in the assembly we can adapt it to a thousand and one applications.

Here again is Result-Engineering . . . modifying a basic design to give you the results of a special . . . at the price of a standard.

Write for Relay Catalog. Ward Leonard Electric Co., 24 South Street, Mount Vernon, New York. Offices in principal cities of U. S. and Canada.

WHERE BASIC DESIGNS IN ELECTRIC CONTROLS ARE RESULT ENGINEERED FOR YOU

WARD LEONARD ELECTRIC COMPANY

RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

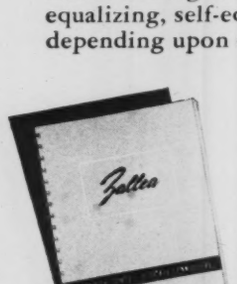
...to the City of Baltimore

BIG city operation requires the best equipment. That's why the carload of Zallea copper Self-equalizing Expansion Joints shown in the picture above are Baltimore bound, to be used in the Back River Sewage Treatment Works.

Installation is intended in the rotary distributor piping which lies deep in the filter beds of this disposal plant. This installation is typical of many jobs specially engineered by Zallea. In this case, because the sewage after being mixed with air is slightly corrosive to the corrugated copper elements, Zallea has wrapped each of the 14", 30", and 36" diameter joints in a bonded neoprene external coating—to add further to their long life.

Dependability and trouble-free performance are built into *every* Zallea Expansion Joint. They *last*, even under the most severe conditions.

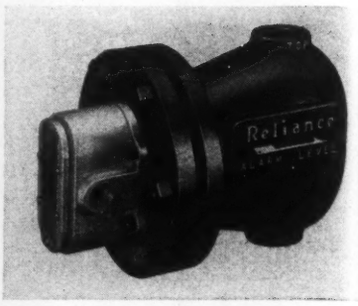
Zallea Corrugated Expansion Joints are made in non-equalizing, self-equalizing, and duo-equalizing types, depending upon operating conditions . . . of copper, stainless steels and corrosion-resistant alloys . . . up to 72" diameter for a wide range of temperatures and pressures. Send *now* for complete information contained in the new Zallea Catalog 47. ZALLEA BROTHERS, 816 Locust Street, Wilmington 99, Delaware.



Zallea
EXPANSION JOINTS

WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS EXCLUSIVELY

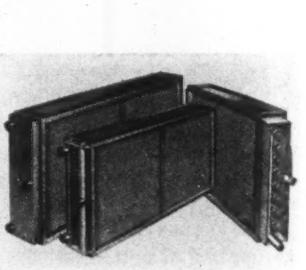
Warns of Low Level in Small Boilers and Tanks



No. 3837 — A new "Levalarm" to set off warning signals, bells, sirens, or warning lights when liquid levels in small boilers or various types of tanks reach a predetermined low or high level, has been announced by Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland, Ohio.

Designed for use on pressures up to 250 psi, the device incorporates an electric switch operated by a permanent magnet when a monel float rises or falls in a separate float chamber. The switch can be wired for a normally open or a normally closed circuit and is said to be dust-, vapor-, and explosionproof.

Coordinates Sizes, Casing Design of Cooling Coils



No. 3838—The new line of cooling coils available from Modine Mfg. Co., Racine, Wis., is said to incorporate important improvements which contribute to simplified and economical installations.

Adaptable to all types of air handling systems, coils are available in a wide choice of types, styles, models, and sizes. Standard and cleanable chilled water coils are offered in a total of 24 models and five casing widths and 17 lengths. Direct expansion type coils are furnished in four models and in the same casing dimensions. In addition to the cataloged line, the company produces custom built coils for installation in equipment manufactured by other firms.

These cooling coils are coordinated in size and casing design with the company's standard, nonfreeze, and hot water heating coils for combinational use.

Finned Radiation Element Has Multiple Uses

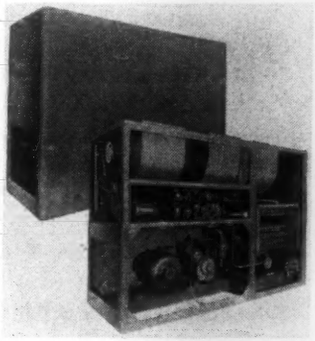
No. 3839—Designed originally for use on locomotive compressed air lines, the "All-Cast" directional finned radiation element offered by Wilson Engineering Corp., 122 S. Michigan Ave., Chicago 3, Ill., is being used for a variety of other heat exchange applications.

According to the manufacturer, the element is being used to condense moisture out of air lines in stationary installations and as after coolers on the high side of compressors. Other uses are said to include industrial unit heaters which require no louvers because of the directional fins in the elements themselves. Also stressed are applications as diesel locomotive fuel oil heaters and in a diesel locomotive de-icing and drying machine manufactured by the company.

Featuring inclined radiation fins which are designed to direct the flow of air and increase the strength, the element is tested at 500 psi and is recommended for

service with steam, gas, or liquid up to 400 psi. The construction is said to permanently resist corrosive fumes and electrolytic deterioration.

Redesigns Central Station Air Conditioning Unit

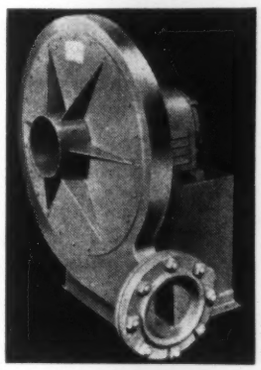


No. 3840—A new overall design incorporating many improved features has been given the "Kooler-aire" central station, packaged air conditioning unit, according to the manufacturer, United States Air Conditioning Corp., 33rd and Como Ave., S. E., Minneapolis 14, Minn.

New features are said to include a more attractive streamlined design, the use of heavier gage steel in the cabinet, larger motors with full thermal overload protection, and an increase in the size of the evaporative condenser section. Cooling coils have also been increased in depth and a reduction of turns and elbows has been effected in the refrigerant line.

Units are shipped completely wired and charged, and are available in 9 sizes ranging from 3 to 40 tons.

High Pressure Blower Serves Many Uses

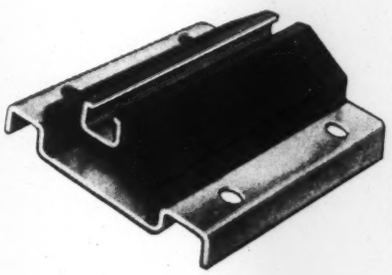


No. 3841** — The "National" centrifugal blower, developed by Combustion Systems, Div. of Vapofier Corp., 10316 S. Throop St., Chicago 43, Ill., is designed to furnish air at high pressure for use with oil and gas burners, for scale blowing and air curtains, for vitreous enameling, and for numerous applications in foundries, glass, brick, and tile plants, etc.

Also said to be ideal for pneumatic systems, the blower has a flanged discharge outlet and is furnished with a companion flange. It is constructed throughout of 3/16 in. welded steel plate and is reinforced with triangular gusset plates.

Other new products offered by the company include a welded steel plate exhauster, designed for air recirculating or high temperature exhausting, and a multiblade type exhauster designed for heating, ventilating, and air conditioning systems.

Vibration Control Unit Designed for Large Frequency Range



No. 3842 — Lord Mfg. Co., Erie, Pa., describes its "Chan-L-Mount" as a packaged vibration control featuring easy installation, strength, and adaptability.

The mounting is

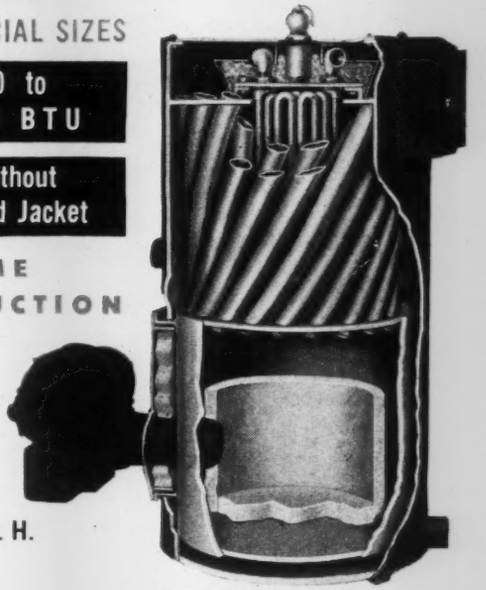
Delivery NOW

4 COMMERCIAL SIZES

417,000 to 1,043,000 BTU

With or without Insulation and Jacket

ASME CONSTRUCTION



Complete Line of Conversion Burners 0.65 to 20.0 G. P. H.

MT. HAWLEY

BOILER-BURNER UNITS WITH Exclusive SPIRAL TUBES

Immediate delivery on *all* models! You get sensational performance and economy with Mt. Hawley's exclusive Spiral Tubes — spiral design extracts more heat — reduces stack temperature approximately 100°. Entire unit is completely accessible. "Wet bottom" eliminates need for fire-proofing — water circulates under combustion chamber. Available in galvanized models for commercial hot water. Built in tankless heater available in all models.

3 DOMESTIC MODELS — 104,000 to 261,000 BTU

MT. HAWLEY MFG. CO.
Mt. Hawley Airport, Peoria 4, Ill.

☐ dealer
Send specifications and ☐ jobber price list on MT. HAWLEY ____ Boiler-Burner units ____ Oil Burners.

Firm ____

Street ____

City ____ State ____

Name ____

mhm CO.

MT. HAWLEY MFG. CO.
MT. HAWLEY AIRPORT—1
PEORIA 4, ILLINOIS

Ready
TO THREAD PIPE QUICK-AS-A-WINK

RIDGID No. 65R gives you fast get-ready, perfect threads on 1" to 2" pipe

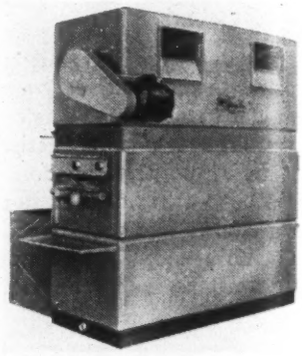
● It's all set to size in just 10 seconds to cut perfect pipe threads on 1," 1¼," 1½" or 2" pipe. Workholder sets instantly—only 1 screw to tighten on pipe—no bushings. RIDGID 65R is self-contained, no extra dies to haul around or lose. Fast accurate threads on iron, steel, brass or copper pipe or conduit, with surprisingly little effort. Every 65R is factory-tested—see test sample in each new tool. Buy from your Supply House.

RIDGID
WORK-SAVER PIPE TOOLS
THE RIDGE TOOL COMPANY • ELYRIA, OHIO

1½ in. high and is installed by sliding under the machine to be mounted. The bolt head is inserted in either end of the metal channel which holds it while the nut is tightened. A cushion of soft rubber is designed to prevent metal-to-metal bottoming under occasional shock.

The manufacturer states that a deflection of ¼ in. permits isolation of frequencies as low as 600 cpm, in addition to all the higher frequencies. The unit is recommended for such installations as pumps, air compressors, motor generators, air conditioning units, refrigerators, etc.

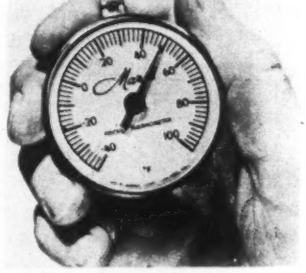
Sectionalized Construction Used in Central Station Conditioners



No. 3843 — Available in eight models with capacities from 3 to 50 tons, the year 'round, central station air conditioning units offered by McQuay, Inc., 1601 Broadway St., N.E., Minneapolis 13, Minn., are designed to provide ease of installation and servicing.

All connections are exposed and conveniently grouped, and sectionalized construction with removable panels is used. The units incorporate the company's "Ripple-Fin" coils with fins mechanically bonded to tubes by hydraulic expansion. Both floor and suspended types are offered.

Dial Thermometer Made in Pocket Size

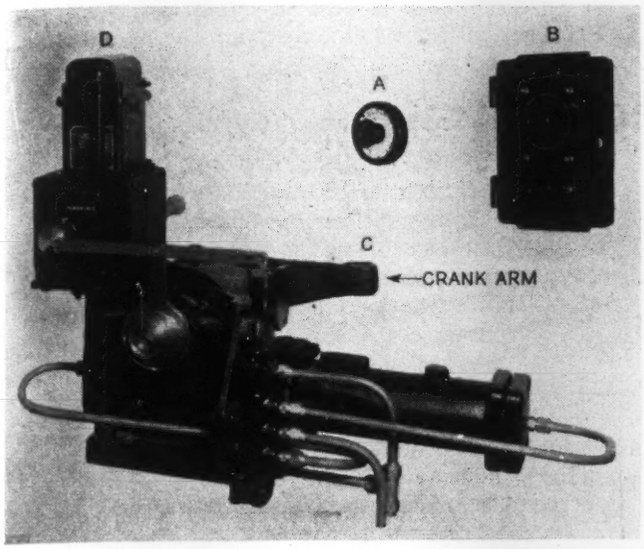


No. 3844—A versatile, low priced dial thermometer manufactured in watch-like pocket-size is now available from Jas. P. Marsh Corp., Dept. 13-P, Skokie, Ill.

In addition to convenient size, the new thermometer is said to offer the easy-reading feature of a dial type thermometer. It measures 2-3/16 in. in diameter and has a polished case of stainless steel. A spring clip, mounted on a swivel, serves to hold the thermometer in the pocket when not in use, or serves as a hanger when taking temperature. Should it ever be knocked out of adjustment, the "Recalibrator Slide" on the back is set to coincide with a thermometer of known accuracy. The crystal is unbreakable.

Electronic Control Positions Hydraulic Cylinders

No. 3845—An electronic control system for positioning hydraulic cylinders having power outputs up to 7500 lb has been announced by Askania Regulator Co., 240 E. Ontario St., Chicago 11, Ill. Remote control stations may be installed at points 1000 ft or more from the location of the cylinder, and accuracy of cylinder movement of 0.10 percent is claimed.



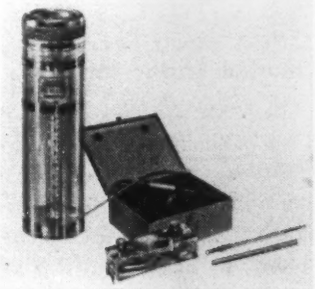
The two station control system shown here consists of: (A) a remote transmitter at one station, (B) a transmitter and amplifier at the other station, (C) a hydraulic crank type cyclinder, and (D) a receiver mounted on the cylinder. The position of the cylinder crank arm can be selected at either control station. An electric signal of the position selected is transmitted to the receiver motor which operates a pilot valve positioning the crank arm at any point within its 90 deg arc.

Packaged Dehumidifying Unit Has Many Applications

No. 3846—According to Surface Combustion Corp., 2375 Dorr St., Toledo 1, Ohio, the new model B "Kathabar" package unit is designed for many dehumidifying applications.

Available in sizes for 1350, 2500, 3500, and 5000 cfm, the units are designed for use in comfort applications, industrial processing where individual control of humidity is desired, for preventing frost on refrigeration coils which operate at temperatures as low as —80 F, and to control humidity and permit an increase in the amount of ventilating air being handled by existing air conditioning systems.

Simplified Construction Features CO_2 Indicator



No. 3847—A new CO_2 indicator, model 600, for testing the efficiency of oil burners, furnaces, and other heating plants has been announced by F. W. Dwyer Mfg. Co., 317 S. Western Ave., Chicago. Featuring simplified construction, the instrument is said to afford accuracy at moderate cost.

It is constructed of transparent acrylic material with metal parts of stainless steel. Pressure-tight "O" rings are used as seals. The indicator is 8 in. long and 2 in. in diameter.

Said to be capable of making three tests a minute, the indicator has a 4 in. scale calibrated to 0.20 percent CO_2. Accuracy is stated to be 0.50 percent CO_2.

No PIPE WRENCH HOUSING EXPENSE *-ever*

RIDGID economy guaranteed

. . . and you like its work-saver features, too

● The RIDGID housing guarantee is just one of the reasons why the RIDGID heavy-duty pipe wrench is the favorite of men who know fine tools—all over the world. Note the easier-work features: adjusting nut in open housing spins easily in all sizes 6" to 60"; handy pipe scale on hookjaw; instant-action non-slip non-lock jaws; powerful comfort-grip I-beam handle. No wonder RIDGIDs are the most popular pipe wrenches made. You'll prefer them, too. Buy them at your Supply House.

Handy end wrench for pipe in coils or against flat surfaces.

UNCONDITIONAL GUARANTEE
If this Housing ever Breaks or Distorts we will replace it Free
COPR. 1947
THE RIDGE TOOL CO.
ELYRIA, O.

RIDGID
WORK-SAVER PIPE TOOLS
THE RIDGE TOOL COMPANY • ELYRIA, OHIO

JOHNSON & JOHNSON
specifies
Kno-Draft Air Diffusers in New Plant

Picked for appearance and performance

ARCHITECTS, THE BALLINGER CO. • INDUSTRIAL DESIGNER, HERBERT ROSENGREN

APPEARANCE: Note the simplicity of design of the Kno-Draft Air Diffuser (arrow) in the reception room of the new Johnson & Johnson plant in Cranford, New Jersey. It enables these diffusers to blend with either modern or period interiors. In their original aluminum, Kno-Draft Diffusers furnish an unobtrusive decorative accent. Painted to match the ceiling, they become self-effacing.

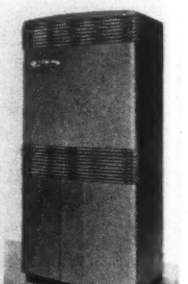
PERFORMANCE: A close-up through the show window in the reception room discloses the manufacturing area of this modern plant. Those Kno-Draft Diffusers in the ceiling are delivering conditioned air in a pattern that eliminates drafts and maintains uniform temperature and humidity throughout the area. Since Kno-Draft Diffusers can be adjusted to control air direction, volume and throw, "custom-made" air patterns were created to meet the exacting requirements of product quality control and employee comfort established in this baby products plant.

Send for your FREE copy of our new handbook on air diffusion. It contains all the data to enable you to create "custom-made" air patterns and eliminate drafts. Please write Dept. D-14.

W. B. CONNOR ENGINEERING CORP.
Air Diffusion • Air Purification • Air Recovery
112 East 32nd Street W.B. CONNOR **New York 16, N.Y.**
IN CANADA: Douglas Engineering Co., Ltd., 190 Murray Street, Montreal 3, P. Q.

An aspirator bulb is used to pump the gas sample into contact with the solution which, the manufacturer states, is good for 1000 tests and is easily recharged.

Hermetically Sealed Compressor Used in Packaged Conditioner



No. 3848*—Distribution of three sizes of "Shipley" air conditioners is now under way by York-Shipley, Inc., York, Pa. Units, available in 3, 5 and 7½ hp sizes, feature two stage hermetically sealed compressors which are said to provide efficient operation and to save on water consumption. All units are enclosed in the same size cabinets and will be distributed through the company's distributors and dealers.

The conditioners are said to be lightweight, ranging from 884 to 950 lb, and to require only three piping connections and one electrical connection. Cabinets are of 20 ga steel and measure 85 in. high. The width and depth are approximately 39 and 24 in. respectively. The 12 in. diameter blowers are designed to deliver 1500, 2000, and 2250 cfm from the 3, 5, and 7½ hp units respectively. Metal air filters of the cleanable type are used and four row "Freon" evaporator coils are used in the two smaller units while a six row coil is used in the larger.

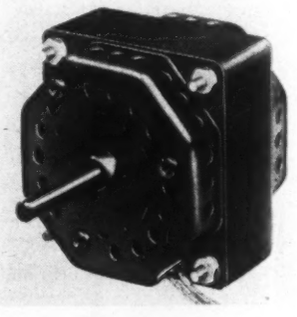
Glass Fiber Insulation Quiets Conditioning Units

No. 3849 — "Fiberglas" blankets, composed of glass fibers with average diameters of 0.00011 in. and bonded with a thermosetting resin, are suitable for quieting self contained air conditioning units, according to Owens-Corning Fiberglas Corp., 1911 Nicholas Bldg., Toledo, Ohio.

Installed in the interior of a unit and its adjacent plenum chamber, the blankets are said to absorb sound waves, to have high thermal insulating efficiency, to be noninflammable, and, under conditions of extreme humidity, to pick up less than 1 percent by weight of water vapor.

Blankets are held in place by special adhesives and are available in ½ in. and 1 in. thicknesses, in rolls 54 in. wide and 25 and 50 ft long.

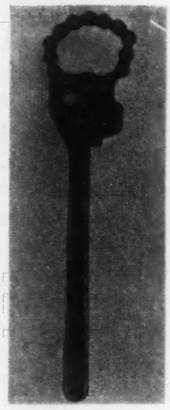
Offers Small Four Pole Shaded Motor for Many Uses



No. 3850 — The model B four pole, shaded pole induction motor, available from Alliance Mfg. Co., Alliance, Ohio, has been designed to drive a variety of mechanical devices, including fans, unit heaters, and blowers.

The range of power is from 1/100 to 1/25 hp, and important advantages are said to include economy of operation, low induced hum, low magnetic field, a flexible power range, and compactness.

Chain Tong Wrench Turns Pipe Right or Left



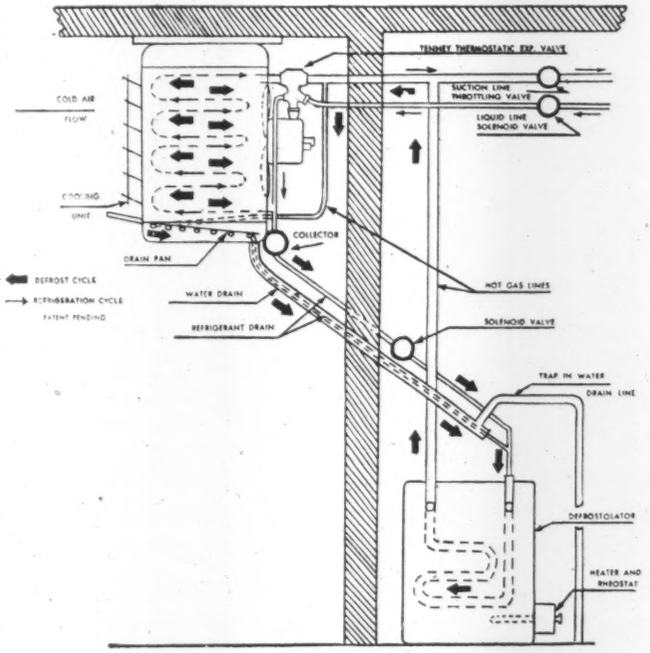
No. 3851**—Designed to turn pipe either to the right or left at one setting and without adjustment, the chain tong wrench, offered by E-Zee Tool Mfg. Corp., 136 Liberty St., New York 6, N. Y., is said to provide an unusual amount of chain wrap.

Recommended for handling pipe in corners, coils, banks, and other tight spots, it is provided with an adjusting bolt for applications where a tight chain may be required.

Defrosts Low Temperature Refrigeration Unit Coolers

No. 3852—A hot gas defrosting system, developed primarily for use in connection with the company's low temperature unit coolers, has been announced by Tenney Engineering, Inc., 26 Avenue B, Newark 5, N. J.

Chief advantages, according to the manufacturer, include rapid defrosting so that excessive temperature rise does not occur, accurate control of the defrosting cycle, and the fact that the capacity and speed at which defrosting occurs is not limited by the size of the condensing unit, as the system is so arranged that it is not necessary to connect into the discharge side of the compressor.



Because of the flexibility as to heat source, the manufacturer states that the system is adaptable to a wide variety of applications, though it is currently being used exclusively on holding room service for frozen foods.

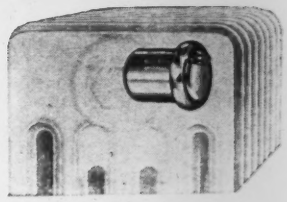
Equipment Shorts

A new multi-million dollar chemical plant for the manufacture of silicone materials has been completed in Waterford, N. Y., by the chemical department of General Electric Co. In partial operation for about a

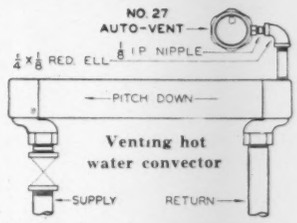
A SURE THING!

STOP Hot Water Circulation Troubles!

Now You Can AUTOMATICALLY Vent Out the Air that Causes "Sick" Radiators and High Cost Heating



AUTO-VENT installed on hot water radiator.



Thousands of contractors have already seen the light!

Instead of taking a chance on manually operated vents (air chamber plus copper tubing plus key valve), they now use Maid-O'-Mist AUTOMATIC Air Eliminators as standard equipment on their hot water jobs.

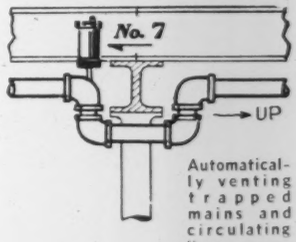
And when you figure total costs — **labor and materials** — they say that Maid-O'-Mist AUTO-VENTS actually cost LESS installed. Think of the customer good-will they build.

CASH IN
ON THIS PROFITABLE IDEA

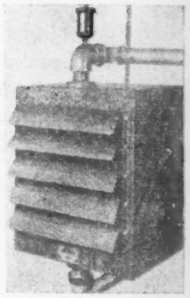
By automatically and continuously VENTING OUT the air as it accumulates in a convector, you're certain to get satisfactory, low cost heating.

That's exactly what Maid-O'-Mist AUTO-VENTS do!

They are FULLY automatic, trouble-free. At least stock a few to "iron out" trouble jobs!



Automatically venting trapped mains and circulating lines.



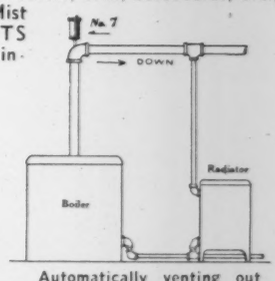
Automatically venting out air from hot water unit heater.

We have three types—for pressures to 75 lbs.

And Note Other "Spots" Where AUTO-VENTS Protect Your Reputation

Circulation "troubles" of many different kinds can be overcome by using these low priced Automatic Air Vents. Study the pictures!

Yes, wherever air pockets or air traps are also likely to clamp down on free circulation in pipe lines, unit heaters, coils, baseboards, etc., Maid-O'-Mist AUTO-VENTS should be installed.



Automatically venting out air from overhead hot or cold water lines.

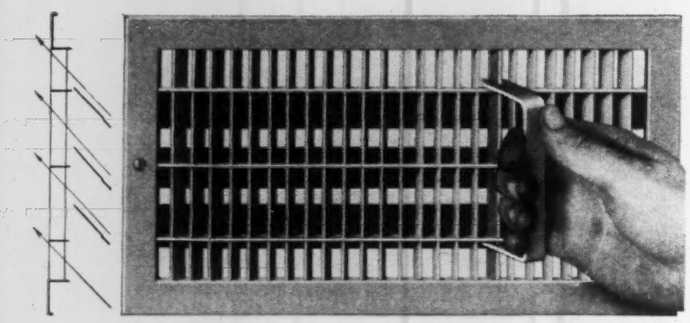
TODAY write for complete Maid-O'-Mist data and attractive prices, or see your jobber.

MAID-O'-MIST INC.
3215 N. PULASKI RD.
CHICAGO 41, ILLINOIS

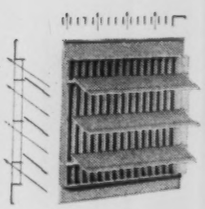
AUTOMATIC HUMIDIFIERS FOR ALL TYPES OF HEATING SYSTEMS

INDEPENDENT

"Fabrikated" WALL GRILLES WITH DEFLECTING VANES



Style 321-A grille with deflecting vanes



Rear view showing adjustable deflecting vanes

ACCURATE and positive compound deflection of air flows can be readily secured with these "Fabrikated" grilles. Directional adjustments may be made when grilles are installed; or grille bars and vanes may be adjusted after installation to meet unforeseen or changed requirements.

Each grille bar and each deflecting vane is adjusted *individually* with a special two-pronged tool included with each shipment. Locking of grille bars and vanes is not required because they are held firmly in place — no vibration — no rattle.

Write for Our New Catalog No. 48.

MEMBER NATIONAL WARM AIR HEATING AND AIR CONDITIONING ASSOCIATION INDOOR COMFORT

Always Leading—Always Progressing

THE INDEPENDENT REGISTER CO.

3747 E. 93rd STREET · CLEVELAND, OHIO

Equipment Shorts (Cont.)

year, the new plant is now ready to produce various types of silicone products processed in the form of rubber, oils, greases, resins and water-repellents.

Tube Turns, Inc., Louisville, has acquired the Pennsylvania Forge Corp., according to a recent announcement by George O. Boomer, president of Tube Turns and its affiliate, the Girdler Corp. He will be chairman of the board of the Philadelphia firm and James S. Kerwin, president, W. T. J. Huggard, secretary-treasurer, and other officers will continue in their present capacities. The business of the subsidiary will be continued under its present name.

More than 500 veteran employees of Minneapolis-Honeywell Regulator Co. recently attended a dinner at which 40 pins denoting from 20 to 40 years service with the company were awarded. Recipients included H. W. Sweatt, president, who received a 35 year pin, and Mark C. Honeywell, chairman of the board, who was given a 40 year pin.

Herman Nelson Corp., Moline, Ill., is planning to erect a factory building which will provide 56,000 sq ft of additional manufacturing and warehousing space.

Plans for the construction of a complete new manufacturing plant and headquarters offices have been announced by Lincoln Electric Co., Cleveland. Preliminary studies for the new plant, which will represent an investment of more than $10 million, are being developed by the Austin Co. The new facilities will ultimately provide about 25 acres of floor space under one roof and will completely replace the company's present plant.

Baltimore Aircoil Co., Inc., Baltimore, has recently reduced the price of its evaporative condensers. Increased production and greater efficiency are said to make possible a reduction in manufacturing costs.

Construction has been started on a new building to house the metallurgical, physical, and chemical laboratories of Edward Valves, Inc., East Chicago, Ind., a subsidiary of Rockwell Mfg. Co. The factory will be used for research and development work on Edward and Norstrom steel valves. The new two story building, which will nearly triple the company's present research facilities, will be completely air conditioned and will be used to consolidate several types of research into a unit arrangement.

A General Electric Co. 250 lb ft torque meter is being used for testing large fans in a wind tunnel at Jeffrey Mfg. Co., Columbus, Ohio. Use of the torque meter is said to reduce the time required to test the fans to 0.25 percent of the original period. The unit is also said to

determine within ± 1 percent of full scale the amount of torque supplied.

Plant Rubber and Asbestos Works, for many years a corporation wholly owned by the Paraffine Companies, Inc., San Francisco, is now officially known as the Insulation Division of Paraffine. R. H. Chase, formerly vice president and general manager of the works, will continue to administer the policies of the new division. He emphasizes that insulations marketed by the "Pabco" division will be identical to those manufactured under the "Plant" trade mark. These will include molded 85 percent magnesia insulation and "Prasco" high temperature insulation.

Air Reduction Sales Co., New York City, has adopted a new set of boxes and cartons for packaging its line of welding torches, tips, cutting attachments, regulators, and other products. The purpose of the new orange and black containers is to afford greater protection to products, to permit better dealer stock control, and easier handling.

L. J. Mueller Furnace Co., Milwaukee, was recently awarded a "certificate of public service" by the Brand Names Foundation in recognition of the 91 years which the brand name, Mueller, has been in continuous use.

Jones and Brown, Inc., national distributor of "Ko-Z-Aire" conditioning units, recently celebrated the opening of its new Pittsburgh headquarters. A newly remodeled building houses the company's executive, sales advertising and accounting offices.

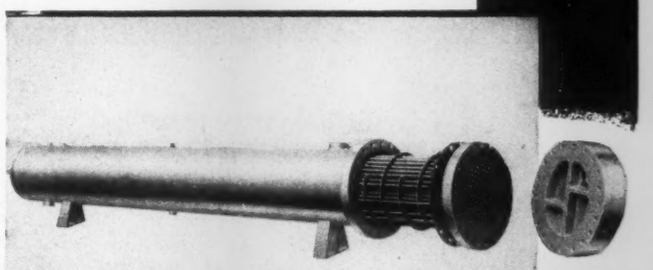
Manning, Maxwell & Moore, Inc., Bridgeport, Conn. has acquired the hydraulics division of Airex Mfg. Co. Long Island City. According to a recent announcement industrial applications will be developed for the division's hydraulic products which include relief valves filters, other hydraulic valves, and pneumatic pressurizing valves for the aircraft industry. Operations of the division will be carried on at its Jersey City plant.

Completion of a black and white, 16 mm sound film running 18 min has been announced by Zonolite Co., 135 S. La Salle St., Chicago. The movie presents the history and detailed applications of "Vermiculite" as loose fill insulation and lightweight aggregates for plaster and concrete. The film is available to interested organizations.

Roberts-Gorden Appliance Corp., Buffalo, is now producing a dual fuel conversion burner under license by the Midwest Research Institute. Forced warm air furnaces and boilers will be offered as complete units. At a predetermined peak load temperature reading, regulated by an outdoor control, the unit automatically switches from gas to oil. When the temperature again goes above that mark, the unit reverts to gas. A 275 gal oil tank is supplied with the conversion unit.

PATTERSON-KELLEY
Heat Exchangers
AND
Process Equipment

Heat-Transfer
SPECIALISTS



Specializing
IN REFRIGERANT
COOLERS

The very essence of "air conditioning" is the controlled transfer of heat.

It was entirely logical, therefore, that Patterson-Kelley engineers, who have specialized for years in heat-transfer equipment, should turn their attention years ago to refrigerant coolers, condensers and other heat-transfer equipment needed in air conditioning and refrigeration systems.

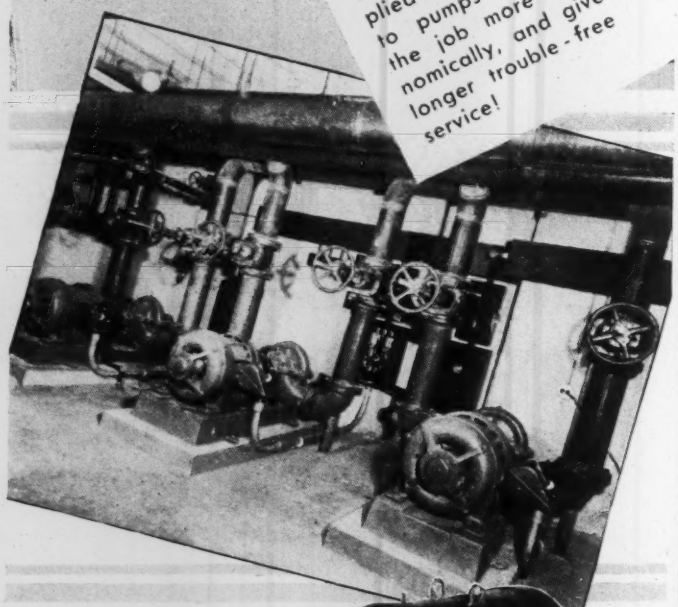
Today, Patterson-Kelley Equipment, coolers for example, is considered by many to be the standard for such installations.

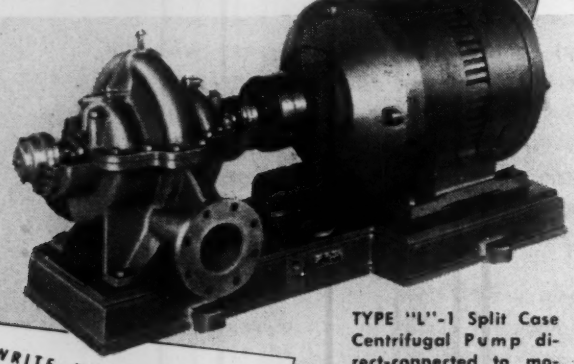
EST 1880
THE PATTERSON-KELLEY Company, Inc.
107 WARREN STREET, EAST STROUDSBURG, PA.
NEW YORK 17—101 Park Ave. PHILADELPHIA 3—1700 Walnut St.
CHICAGO 4—Railway Exch. Bldg. BOSTON 16—96-A Huntington Ave.
Representatives in Principal Cities

proven dependability

● You can always judge a pump by the company it keeps! That's why it's so significant that WEINMAN CENTRIFUGAL PUMPS will always be found, hard at work, whenever the job calls for day in and day out DEPENDABILITY! Weinman pumps are designed and engineered by Centrifugal Specialists who KNOW THE AIR CONDITIONING FIELD, and have applied this knowledge to pumps that do the job more economically, and give longer trouble-free service!

Three Type L-1 Weinman Pumps in the 4,902,196 cu. ft. Air Conditioning Plant of the F. & R. Lazarus & Co., Columbus, Ohio . . . Central Ohio's largest department store.





TYPE "L"-1 Split Case Centrifugal Pump direct-connected to motor. Capacities of 160 GPM to 3,500 GPM . . . heads to 230 ft. Write for bulletin No. 627-2

WRITE, WIRE, OR PHONE FOR ANY INFORMATION ABOUT PUMPS OR PUMP INSTALLATIONS . . . IT'S FREE SERVICE!

Built by Centrifugal Specialists

The WEINMAN Pump Mfg. Co.

COLUMBUS · 8 · OHIO

Equipment Shorts (Cont.)

A Safety Aid Dial has been introduced by Davis Emergency Equipment Co., Inc., 45 Halleck St., Newark 4, N. J. The dial, which is a circular slide rule printed on heavy coated cardboard, provides information on 45 different mechanical operations in industry with suggested head, eye, and face protection for each operation. Data on body and respiratory protection are also included. In addition, 55 different fumes, vapors, gases, dusts, etc. are listed and information is given on the probable safe concentration for an 8 hr exposure, suggested protection and control measures, the usual methods of entrance to the body, flash points, and lower explosive limits. According to the company, all information on the dial has been taken from authoritative sources.

The Foxboro Co., Foxboro, Mass., is now conducting a series of courses, each of two weeks duration, on the theory, application, operation, and maintenance of industrial instruments. Two week courses will be held in August, October, November, and December. Training classes will also be arranged for companies wishing to send a group sufficiently large to warrant a special class for study of particular instruments and applications. In addition, special courses will be arranged for specific industry groups. Similar courses are offered by the Foxboro Co. Limited, Montreal. Enrollment application forms are available at the company's home office or any of its branch offices.

Morrison Products, Inc., Cleveland, recently observed its 25th anniversary, a significant milestone in the growth of the organization and its plant facilities.

A new "Mark-Time" series 5400 dual purpose, bell-electric switch combination timer unit has been developed by M. H. Rhodes, Inc., Hartford, Conn. It is designed to break an electric circuit and ring a bell after a predetermined time interval. Standard timing is 60 min at 1 min intervals. However, any time duration from 60 sec to 12 hr can be provided on specification.

"Siloo" parts cleaner is now available in quart cans for the cleaning of small metal parts. According to the manufacturer, Petroleum Solvents Corp., 331 Madison Ave., New York City, the size was brought out especially for oil burner repairmen and mechanics. It is designed to remove sludge, grease, carbon, and dirt deposits from all metal parts.

"Plastic Patch" is offered by Howard Paint Div., Reconditioning Products, Inc., 5201 Denison Ave., Cleveland, as a fast, simple and inexpensive method of repairing torn or rusted out sections of heating systems, ventilation ducts, water tanks, pipes, etc. Application is done in three steps; preparation of the surface, smoothing out the patch material over the damaged area, and brushing the company's "New Metal" over the patch.

EXECUTIVE CHANGES

Ric-wiL Co., Cleveland, has appointed Edwin A. Wert as vice president in charge of engineering. He is well-known for his work on piping design and for his several published books on this subject.

John G. Seiler has been elected executive vice president of Tube Turns, Inc., of Louisville. He became associated with the company in 1930, and a year later was appointed sales manager. More recently he has been general sales manager and vice president.

E. (Ed) L. Behrends has joined the general sales department of Taylor Forge & Pipe Works, Chicago.

R. I. Parker is the new commercial vice president of General Electric Co., which he joined as a student engineer in 1913. He has been manager of the apparatus department's central district since 1945, and succeeds W. O. Batchelder who is retiring after 43 years' service.

Worthington Pump and Machinery Corp., Harrison, N. J., has named Harold T. Anderson as assistant to the general sales manager, in charge of sales production relations. He is responsible for receiving and interviewing representatives of customers' organizations who visit the Harrison works seeking information with respect to production schedules of specific orders.

J. A. Cutler, president of Johnson Service Co. and a past president of the University of Wisconsin Alumni Association, has recently been appointed a member of the university's athletic board.

Recently elected vice presidents of Avco Mfg. Corp. are Eric O. Johnson and John W. Craig. Mr. Johnson is also general manager of the firm's American central division while Mr. Craig, general works manager, will succeed R. C. Cosgrove as general manager of the Crosley division. Mr. Cosgrove is executive vice president of the corporation.

Clifford V. Coons has been appointed vice president in charge of sales and G. M. Greenwood has been named vice president and treasurer of Rheem Mfg. Co., New York City. Mr. Coons, general manager of sales since 1945, will continue to make his headquarters in New York. Mr. Greenwood, a member of the board of directors, will continue to be located in the company's San Francisco offices.

Wood Conversion Co., St. Paul, Minn., has made the following sales staff promotions: J. D. Fischer to manager, building product sales; P. L. Berquist to manager, industrial product sales; R. E. Backstrom to assistant products manager; and D. B. Anderson to manager, merchandising department.

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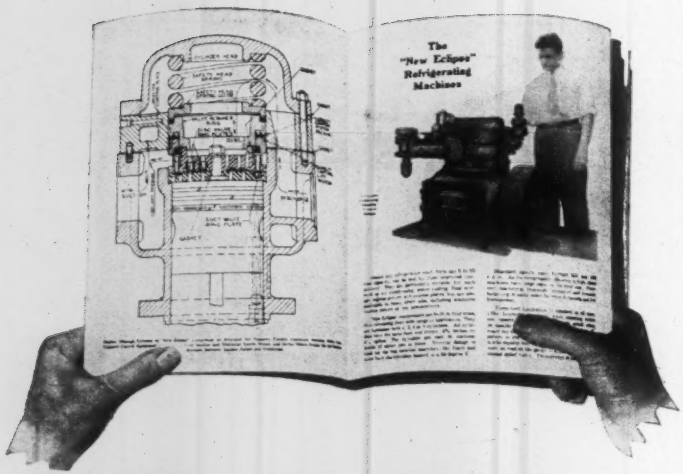

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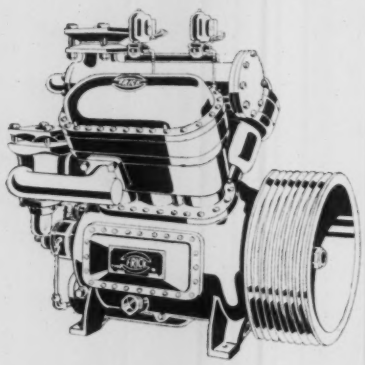
It tells all about the "New Eclipse" compressors . . . how they meet the needs of restaurants, theatres, stores, institutions, offices, factories, ships and others . . . for dependable air conditioning, food storage, or special refrigeration work.



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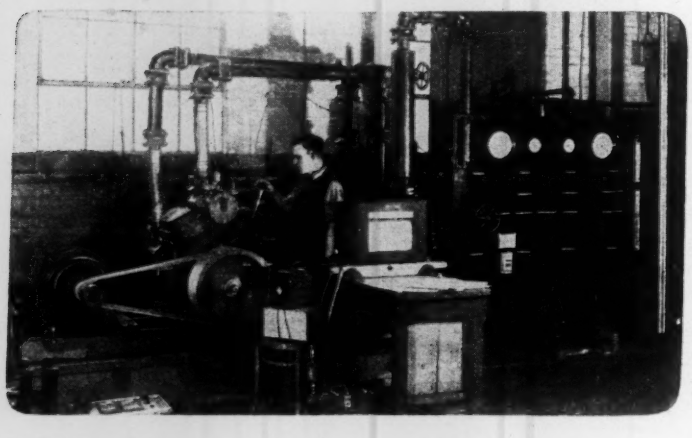

NEW BOOKS & REPORTS

Relative Humidity Has Lethal Effect on Airborne Bacteria

A laboratory investigation of the effect of relative humidity on airborne bacteria indicates that an atmosphere of approximately 50 percent RH has a lethal effect on such microorganisms.

The results of the study, made by E. W. Dunklin and T. T. Puck, are contained in a paper released by the departments of medicine and biochemistry, University of Chicago.

The viability of pneumococcus, Type I, sprayed into the atmosphere from a liquid suspension, was measured as a function of relative humidity. According to the authors, when broth, saliva, or 0.5 percent saline solution is employed as the suspending medium, a very high mortality rate is observed at approximately 50 percent RH. However, at humidities above or below this value the microorganisms survive for long periods.

It is also reported that the disappearance of microorganisms from the air is a true lethal process, rather than a manifestation of aerosol collision. When a saline-free solution was used, the sharp peak in death rate at intermediate relative humidities was found to disappear. The lethal effect was found to increase when the particle size of the atomized droplets was increased or when the temperature was raised.

Cultures of hemolytic streptococcus, Group C, and staphylococcus, sprayed from a broth medium, exhibited the same general survival pattern as a function of relative humidity, though the mortality rates were smaller than in the case of the pneumococcus.

Inasmuch as various studies on the influence of relative humidity have resulted in conflicting reports, the results presented in this paper may be significant in elucidating certain aspects of the epidemiology of airborne infections. The paper, The Lethal Effect of Relative Humidity on Airborne Bacteria, has been reprinted from the Vol. 87, No. 2, issue of the Journal of Experimental Medicine, published by the Rockefeller Institute for Medical Research, 66th and York Ave., New York City.

Reports of Recent Research on Dust Hazards, Explosions

Practically every combustible solid material in finely divided form can produce a dust explosion if it is dispersed into air and ignited. However, atmospheric dust cannot create or of itself propagate an explosion if the dust concentration is kept within safe limits from the standpoint of health. These statements, together with information on the maximum dust concentrations recommended by the U. S. Public Health Service, serve as an introduction to the paper, Recent Research on the Exposibility of Dust Dispersions, by Irving Hartman, supervising physicist, experimental coal mine and dust explosions research section, U. S. Bureau of Mines.

This paper briefly reviews the nature of the dust hazard and the importance of explosions, discusses the various chemical and physical factors which affect explosibility, and describes recent research by the Bureau of Mines. In the portion of the paper dealing with re-

search on explosibility factors, the author discusses lower explosive limits, guncotton flame, relative inflammabilities of dusts, concentrations, composition of the atmosphere (with particular reference to oxygen content), and particle size. He also gives suggestions for reducing the hazard, stressing the importance of adequate relief vents.

The risk of making generalizations with respect to explosibilities for new powders and new situations is pointed out by citing experiments conducted with "Freon" gas which is a good extinguisher for gasoline fires and is normally considered inert. When dust clouds of magnesium powder were dispersed in an atmosphere of "Freon-12" in the presence of an electric spark, violent explosions resulted.

This seven page article has been reprinted from the Vol. 40 issue (page 752) of Industrial and Engineering Chemistry, published by the American Chemical Society, 332 W. 42nd St., New York City.

Heating, Refrigeration, Conditioning Included in Industrial Yearbook

The first edition of an annual encyclopedia of industrial progress contains a section on air conditioning, refrigeration, and heating. D. L. Fiske, consulting engineer, New York City, author of this section analyzes the present status of the industry and indicates its potential development, new manufacturing opportunities, and markets for raw materials and finished goods.

Containing 28 chapters on as many segments of American industry, the book is available from International Industry Yearbook, 551 Fifth Ave., New York City.

Analyzes and Appraises Venting Problems with Gas Appliances

The American Gas Association is sponsoring a general study of gas appliance venting practices and conditions. A progress report, based on material collected in various parts of the country, illustrates some of the conditions which now exist in both natural and manufactured gas areas and provides information on successful venting practices and principles.

The report, Research in Venting Direct Gas Heaters When No Chimney Connections Are Available, by C. E. Blome, research associate, and J. L. Bray, professor of metallurgical engineering, Purdue University, is in the form of a 67 page, nontechnical bulletin. It is identified as Research Series No. 103 of the Engineering Experiment Station, Purdue University, and is available from AGA headquarters, 420 Lexington Ave., New York City, for $1.00 per copy.

Stresses Dimensions of Physical Quantities in Fluid Flow Text

Fluid Flow in Pipes—Its Mechanics and Dimensions is a fundamental text not intended to be a complete treatise but rather a discussion supplementary to the material found in standard books and reference volumes. It is written for engineers and others who encounter only an occasional problem or for those whose knowledge of the subject has become hazy. The treatment of the theory and practice of fluid flow is given primarily to clarify the use of dimensions or units of physical quantities.

While general physical data available elsewhere in

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tabular or graphical form have been omitted, fluids and their properties, viscosity, viscous and turbulent flow, Reynolds number, pipe roughness and friction, together with flow through pipe, fittings, valves, and orifices are discussed and basic equations and example calculations are given.

Reproduced by the photo-offset process, this 159 page, 8 x 11 in. paper covered book is in looseleaf form and is published by the author, Clifford H. McClain, 21 W. Wilmot Ave., Havertown, Pa. It is identified as Technical Manual No. 21 and is priced at $5.00.

Finds Present Welding Not Suited to Thick Sections of Magnesium, Aluminum

A survey of published literature, reports from 50 private firms, laboratories, and government agencies has led to the conclusion that there is essentially no information available on the welding of thick sections of light alloys, that there is a general reluctance on the part of industry to consider the lightweight high strength alloys as weldable in thick sections with presently available materials and processes, though some research is now in progress.

The report, Survey on Welding of Aluminum and Magnesium, was prepared by C. M. Craighead, P. L. Mirolo, R. D. Williams, and C. B. Voldrich, researchers of Battelle Memorial Institute, working under contract with the office of chief of ordnance, Department of the Army.

Summarizing their findings, the researchers report that while there has been very little industrial experience in fabricating light alloy structures by welding wrought sections thicker than 1 in., there has been some inert gas-shielded arc welding of hot rolled magnesium plate 1 in. thick. For the most part, welding of wrought magnesium has been confined to relatively light sections. Citing basic difficulties, the authors explain that most magnesium alloys are produced in two tempers, work hardened and annealed. In areas adjacent to the weld the structure produced by cold work recrystallizes from the effect of welding heat and the joints tend to have properties characteristic of the annealed condition. Maximum joint efficiency is generally obtained when welding the annealed temper.

Tests of relatively light sections of aluminum alloys indicate that with presently available processes and alloys no improvement in joint efficiency is to be expected by increasing the section thickness of the aluminum alloy. It appears that the strength of welded joints in thick sections of high strength aluminum alloys will be limited to the properties of the cast filler. There is a real need for a high strength, heat treatable filler, the authors state.

The report indicates that spot and seam welding appear to be completely impractical for the heavy sections contemplated for ordnance applications, but the possibilities of brazing and flash and pressure welding methods are discussed.

Mimeographed copies of the 298 page report, PB-78712 originally published in January 1947, are now available from the office of technical services, Department of Commerce, Washington 25, D. C. The price is $8.00 per copy and orders should be accompanied by check or

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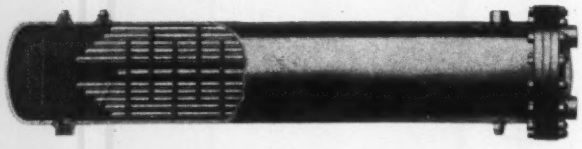
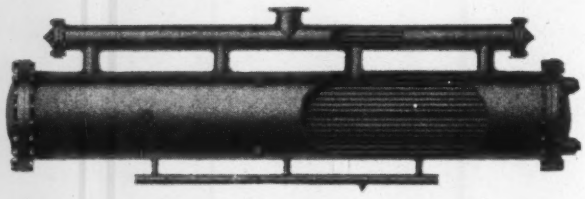


U-TUBE DRY EXPANDED



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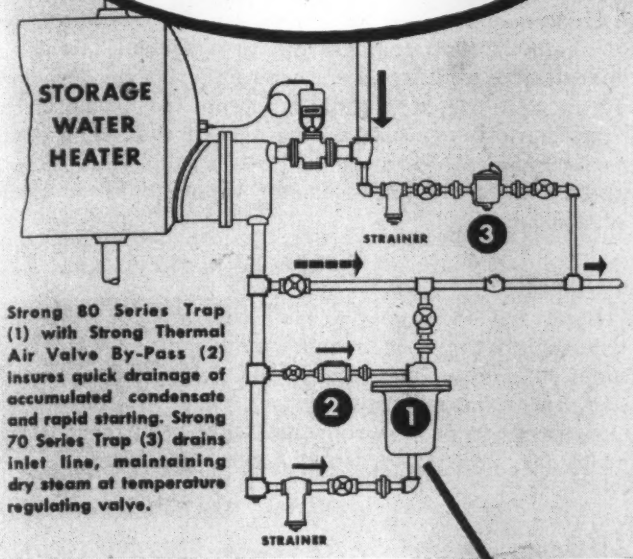

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SOLUTION: *Drain coils fast.* Use trap with four to eight times capacity of actual steam condensate rate. For medium or high pressures, either open or inverted bucket traps are suitable. *Use open bucket traps for low pressures.*

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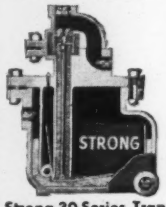

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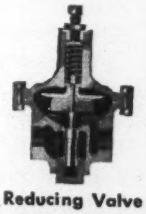
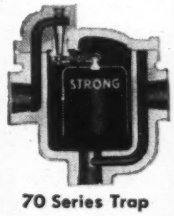


Reducing Valve



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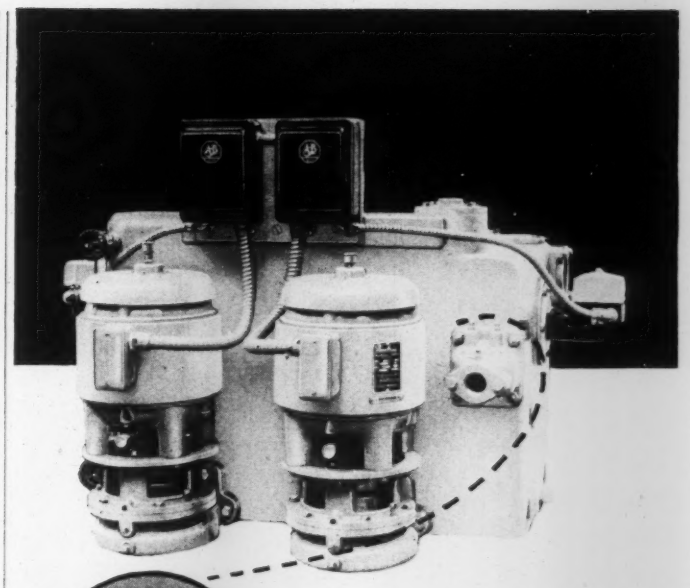

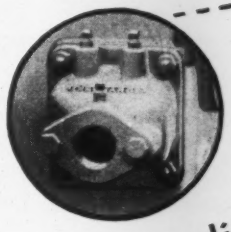

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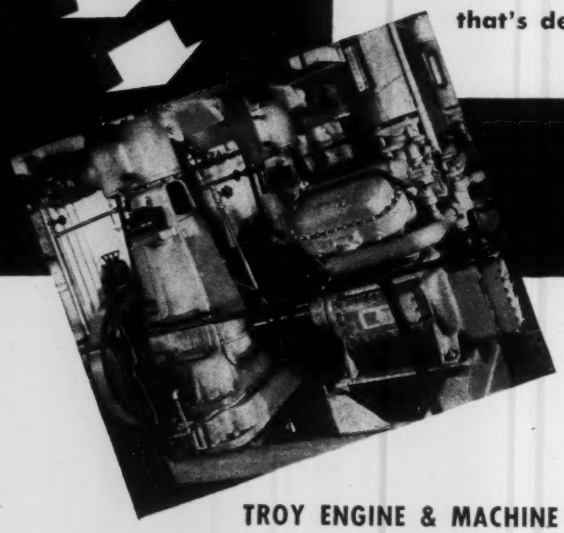

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Other Books and Reports Received

Supplying Household Heating Services by High Temperature Circulating Liquids and Vapors—identified as Research Bulletin No. 3 and prepared by the Institute of Technology, Chicago, it is available from the American Gas Association, 420 Lexington Ave., New York City, for $1.00 per copy. The report gives the results of a literature survey and an analysis of the characteristics of available high temperature heat transfer fluids. A quantitative evaluation is given of the system developed by the J. B. Pierce Foundation. Main conclusion of the investigation, sponsored by the AGA, is that the thermal performance of present domestic gas appliances will probably not be improved by vapor-liquid or liquid systems.

Hotel Buyer's Guide—a new edition has been distributed to the 6000 member hotels of the American Hotel Association, publisher of this "blue book". Over 200 firms and individuals, together with information on their products or services which have been recommended to the industry by many hotels, are listed.

Index to ASTM Standards, published by the American Society for Testing Materials, 1916 Race St., Philadelphia. This revised publication is really an adjunct to the society's 1946 Book of Standards and its 1947 supplements. It is designed to provide rapid location of any of the 1500 odd standard specifications and tests. Copies of the 240 page, paper covered booklet are available at no charge from ASTM headquarters.

NFPA Handbook, published by the National Fire Protection Association, 60 Batterymarch St., Boston 10. This 10th edition is a completely new book containing 73 chapters and including new material on water spray (fog) protection, building construction, magnesium and other combustible metals, properties of flammable solvents, and information on the properties, hazards, proper storage practices, and extinguishing methods for many solvents and chemicals.

The Illinois Smokeless Furnace, by J. R. Fellows, A. P. Kratz, and S. Konzo, professor, research professor, and special research professor of mechanical engineering respectively, University of Illinois. This 80 page, paper covered booklet is published by the Engineering Experiment Station, University of Illinois, Urbana, Ill., is identified as Bulletin No. 370, and is priced at 75 cents. It covers the requirements for the smokeless combustion of bituminous coal, explains the operating principles of the Illinois smokeless furnace developed at the university, describes the test equipment and procedure, and discusses the results of tests made in the laboratory and in the Warm Air Heating Research Residence.

MEETINGS & CONVENTIONS

The Third National Instrument Conference and Exhibit—sponsored by the Instrument Society of America, 1117 Wolfendale St., Pittsburgh 22, Pa. To be held September 13 to 17, Philadelphia Convention Hall.

American Gas Association, 420 Lexington Ave., New York City—1948 convention, October 4 to 8, Atlantic City.

Those planning to attend are urged to make reservations immediately. Application forms for hotel accommodations are available from association headquarters and should be filed with the AGA housing bureau, 16 Central Pier, Atlantic City, N. J.

Many industry-wide problems will be discussed at the general sessions, and sectional programs will delve into virtually all phases of the gas business. The technical section meetings will be devoted to many subjects including synthetic liquid fuels, developments in a newly constructed catalytic cracking plant, uses of LP gases, mains and services, and modernizing existing plants to increase capacity.

American Chemical Society, Chicago section, 1505 S. Wabash Ave., Chicago 5—Fifth National Chemical Exposition, October 12 through 16, Chicago Coliseum.

Plans for this show include the revival of the National Industrial Chemical Conference, which was not scheduled at the last show held in 1946.

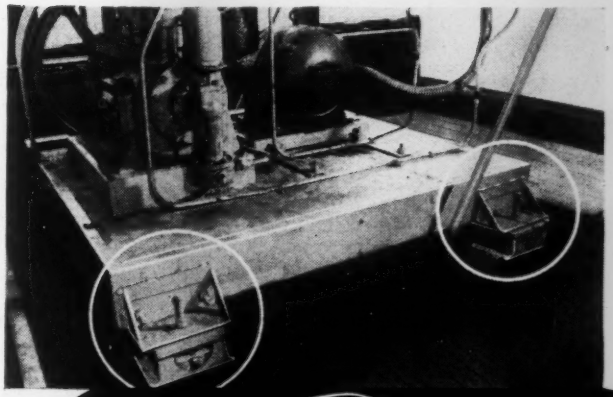
According to Dr. L. E. Clifcorn, chairman of the exposition committee, "the conference will feature noted speakers who will present interesting papers on new developments, discoveries, and applications in industrial chemistry." Sessions will be held in the Coliseum Annex, under the same roof with the show, and all show visitors are welcome to attend the conference.

National Association of Housing Officials, 1313 E. 60th St., Chicago 37—annual meeting. October 13-16, Olympic hotel, Seattle. The Third Annual Exhibit of Building and Maintenance Products will be held concurrently.

American Welding Society, 39 W. 39th St., New York City—annual meeting, October 24-29, Bellevue-Stratford hotel, Philadelphia.

Inert gas-shielded arc welding will be given considerable attention as two of the many technical sessions will be devoted to this subject. A paper on pipe welding, by John H. Zink, president, Heat & Power Corp., Baltimore, will be presented during the session on storage tanks, pressure vessels, and piping.

The concurrent National Metal Exposition will be held



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Locating air conditioning equipment anywhere above the ground floor presents problems, mainly because of excessive vibration and noise in operation. Korfund Standard Vibro-Isolator Units have solved this problem many times.

For example, Valley Weathermakers, Harlingen, Texas, recently installed a reciprocating compressor on the third floor of S. H. Kress & Co. building, Brownsville, Texas. In this instance, installation was made even more difficult by location near the offices and sales floor. Yet today the 2300 lb. compressor and 900 lb., 40 HP motor are operating satisfactorily mounted on four Korfund LK/F Vibro-Isolators. Valley Weathermakers' letter states:

"... These isolators are doing an excellent job of removing vibration caused by the motor and compressor. You can stand in the office directly below the equipment and not be able to tell whether or not (it) is in operation ... The Construction Superintendent for S. H. Kress & Co. ... was very much pleased ... (In another case) we have an air conditioning compressor installed on the second floor of an office building, and it is disturbing the tenants below. From the results of the Brownsville, Texas, job, we feel sure that your Isolators will remedy the trouble on this installation."

It is interesting to note that more than 75% of Korfund orders in the air conditioning field are *repeat* business. We'll be glad to send further details showing why this is so. Write us today about your problems in Vibration Control.

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Meetings & Conventions (Cont.)

in the Commercial Museum and convention halls. The first educational lecture series will be given by Dr. R. D. Stout, department of metallurgy, Lehigh University. His three lectures will be on the metallurgy of arc welds in steel.

American Society of Refrigerating Engineers, 40 W. 40th St., New York City—1948 annual meeting, December 5 to 8, Hotel Statler, Washington, D. C.

The technical program will be under the supervision of C. M. Ashley, chairman of the program committee, and W. S. Woodside will be the convention chairman.

Pan-American Engineering Congress, to be held late in 1948 or in 1949, South America—further information to be released by the Engineers Joint Council Committee on International Relations, 29 W. 39th St., New York City.

Ninth International Heating, Ventilating, and Air Conditioning Exposition, January 24 to 28, International Amphitheatre, Chicago—under the auspices of the American Society of Heating and Ventilating Engineers, 51 Madison Ave., New York City.

American Society of Heating and Ventilating Engineers, 51 Madison Ave., New York City—the 55th annual meeting, January 24 to 27, 1949, Stevens hotel, Chicago.

The Illinois Chapter will be host for the occasion and W. A. Kuechenberg is general chairman of arrangements.

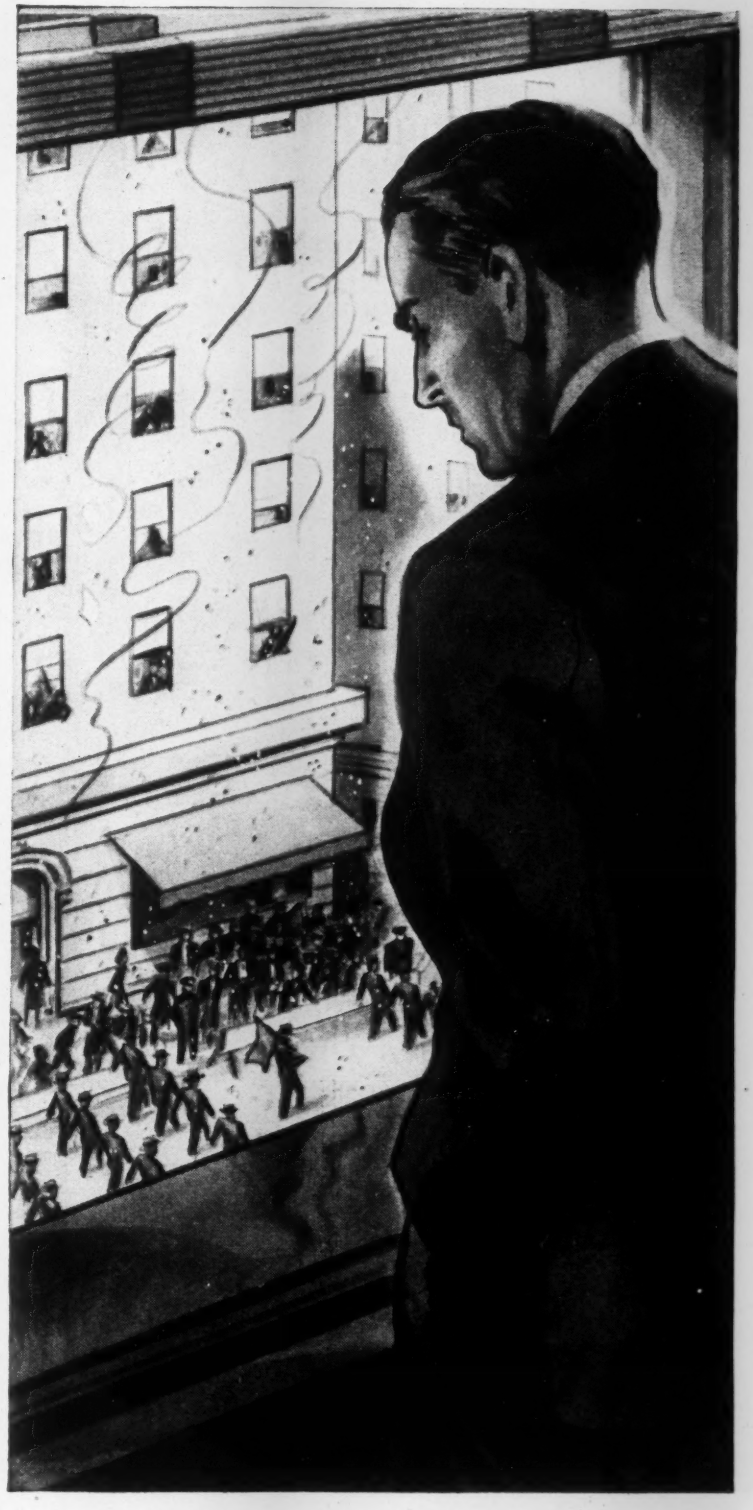
American Foundrymen's Society, 222 W. Adams St., Chicago—1949 annual meeting, May 2 to 5, St. Louis, Mo.

American Society of Refrigerating Engineers, 40 W. 40th St., New York City—proposed 1949 Spring meeting, June 5 to 8. As tentatively planned, the technical sessions and committee meetings will be held aboard ship and will be combined with a cruise, from Montreal, on the St. Lawrence and Saguenay rivers. Stops for sightseeing will be made at Murray Bay, Tadoussac, and Quebec.

Sixth All-Industry Refrigeration and Air Conditioning Exposition, the week of November 14, 1949, Atlantic City—sponsored by the Refrigeration Equipment Manufacturers Association, 1107 Clark Bldg., Pittsburgh 22, Pa.

According to R. K. Hanson, show director, the general public is not invited and visitors must show credentials indicating they are members of the industry.

MEMO TO PRESIDENTS WHO WATCHED THE BAND GO BY!



HERE'S ONE parade that isn't "all over but the shouting" after the band has passed. It's the Payroll Savings Plan for the regular purchase of U. S. Security Bonds by employees.

Though the formal spring campaign to sell Bonds is over, any company can still move forward with the parade. Right now thousands of companies are putting *additional push* behind their Payroll Savings Plans. Managements of many companies that have not yet participated are *now installing* the Plan.

It's a "look-ahead" plan, that benefits employee, company, and nation. Every $3 invested in Bonds pay $4 at maturity. Personnel records in the plants with active P. S. P. programs show improved employee attitudes—evidenced by less absenteeism and fewer accidents—as the individual's sense of security grows with Bond purchases. And every Security Bond dollar built up in the Treasury retires a dollar of the national debt that is potentially inflationary. It means less bidding-up of prices. Moreover, Bond buyers are better citizens because they have a tangible stake in the nation's future.

It's just as easy to take action now as when the campaign was at its height. Just call your Treasury Department's State Director, Savings Bonds Division, and ask for the material that helps to get a Payroll Plan started or to keep it rolling.

The Treasury Department acknowledges with appreciation the publication of this message by

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This is an official U. S. Treasury advertisement prepared under the auspices of the Treasury Department and the Advertising Council.

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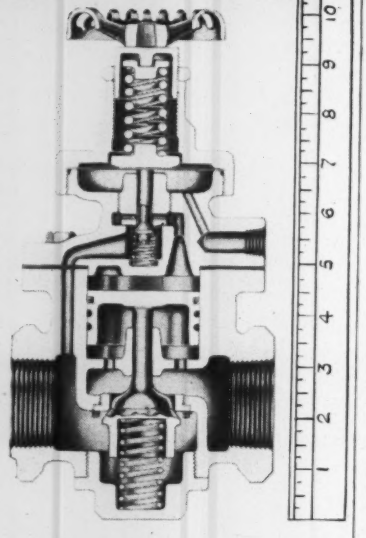
FOR "CLOSE-TOLERANCE" STEAM REGULATION

Where close regulation of steam pressure is important — and space-saving a big advantage — K&M's Type 481 is the valve to use. It's an internal pilot-operated pressure-reducing valve designed to meet just such requirements.

Type 481 is widely used in industrial process services, in marine applications, and as a primary valve on two-stage reductions for heating. Changes in pressure reduction are made by a simple setting of the hand-wheel.



DIMENSIONS

Valve Size (Inches)	½", ¾", 1"	1¼"	1½"	2"
A	4	5	6	6
B	7 5/16	7¾	8½	8½
C	1¾	2 7/16	2 13/16	2 13/16

PARABOLIC INNER VALVE

insures reliable control on high or low load requirements.

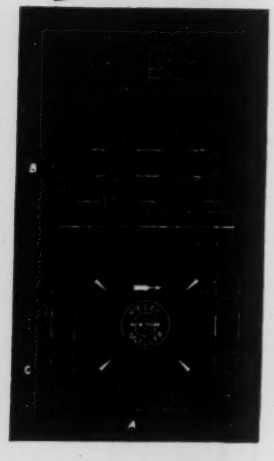
SINGLE-SEAT DESIGN

insures tight shut-off on dead-end services.

EASY MAINTENANCE

All working parts easily removable and renewable without removing valve body from line.

Write for full technical details — and for the 100-page Kieley & Muller catalog, "Automatic Equipment for Pressure and Level Control."



KONTROL KIELEY & MUELLER MOTOR
NORTH BERGEN N.J.

RECENT TRADE LITERATURE

For your convenience in obtaining copies of these bulletins, see coupon on page 189. If you write direct to the manufacturer, describe carefully what literature you want, as the number given first in each item is for use only when sending requests to Heating, Piping & Air Conditioning.

Advantages of Using Anthracite Coal

No. 6917—How to Choose the Right Heating Equipment for Apartments, Office Buildings, Commercial Use is the title of a booklet published by the Anthracite Institute, 101 Park Ave., New York 17, N. Y. It illustrates the various types of equipment commonly used for burning anthracite and describes the advantages of this fuel from the standpoint of fuel supply, fuel cost, and maintenance.

Air Conditioning Units, Unit Heaters, and Evaporative Condensers

No. 6918—A series of data sheets giving specifications, dimensions, and physical data on air conditioners, unit heaters, and evaporative condensers has been issued by Worthington Pump and Machinery Corp., Harrison, N. J. Data Sheets C-1100-S64 through C-1100-S66 respectively cover series AHY horizontally suspended, series AVY vertical floor mounted, and SCY models of packaged air conditioners. Series ECZ evaporative condensers for ammonia and "Freon-12" are covered on sheets C-1100-S67 and C-1100-S68 while the company's line of unit heaters, UHY series, is described on data sheet C-1100-S70. Series RCY packaged air conditioners is the subject of sheet C-1100-S69.

Air Heaters of the Direct Fired Type

No. 6919—The history and development of Dravo Corp., Neville Island, Pittsburgh 25, Pa., is briefly told in a 24 page bulletin (No. 902-A) which also discusses the company's use of stainless steel for combustion chambers of space heaters and describes many fields of activity in which the company has progressed. These include the design and installation of industrial heating systems and air cooled units for conditioning crane cabs.

Blow Torches and Fire Pots

No. 6920—Catalog G, released by Clayton & Lambert Mfg. Co., 1701 Dixie Highway, Louisville 10, Ky., lists the company's line of blow torches and fire pots. Design and construction features of the many types are covered and a repair parts list is included.

Bronze Gate Valves

No. 6921—The 200 lb (steam pressure) union bonnet, bronze gate valves of the Lunkenheimer Co., Waverly & Beekman Sts., Cincinnati 14, Ohio, are described and

illustrated in a folder which covers design and construction features and lists overall dimensions.

Cellular Glass Insulation

No. 6922—"Foamglas" insulation, composed of countless air cells sealed in glass, is produced by Pittsburgh Corning Corp., 632 Duquesne Way, Pittsburgh 22, Pa. It is now available in block form for core wall insulation and for insulating roofs and floors. These blocks are described in bulletins which provide information on heat transmission (*U*) factors, moistureproofing joints, and properties of the material. The insulation is also available (in thicknesses from 1 to 4 in.) for cold and hot piping in sizes from ¼ to 36 in. This round form of the insulation is also described and illustrated in a four page booklet.

Centrifugal Pumps

No. 6923—Types CN and CNE centrifugal pumps for belt, multi-v-drive, and motor drive are described and illustrated in Bulletin W-305-B1, published by Worthington Pump and Machinery Corp., Harrison, N. J. Specifications, features of design and construction, ratings, and dimensions are included in the booklet covering these pumps for hot or cold water, brine, process liquors, light oils, and similar liquids.

Cleaning System for Steam Heating, Processing Plants

No. 6924—Pressure-Jet Systems, Inc., 333 W. Reservoir Ave., Milwaukee 12, Wis., has issued a four page folder describing its cleaning system for steam heating and processing plants. A noncaustic inhibitor and/or hydrophylic gel solution is heated to a high temperature and pressure and is injected into the system beyond the boiler. The steam acts as a vehicle carrying the solution through the entire system. According to the company it dissolves scale, sludge, and rust and neutralizes corrosive acids.

Closed Tank Float Switches

No. 6925—Bulletin No. 2050, covering the line of closed tank float switches produced by Automatic Control Co., 1005 University Ave., St. Paul 4, Minn., features both the plug and the flange types. They are designed for closed tank service and are said to be suitable for pressures up to 100 psi and temperatures up to 200 F.

Cup Type Piston Packing

No. 6926—Cup type piston packing with moulded cups of duck and synthetic material for pressures up to 350 psi and temperatures up to 250 F is the subject of a four page bulletin (W-404-B3) issued by Worthington Pump and Machinery Corp., Harrison, N. J.

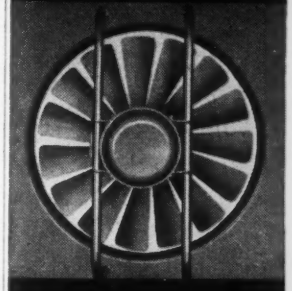
Direct Fired Unit Heater

No. 6927—The Thermobloc Div., Prat-Daniel Corp., East Port Chester, Conn., has issued an eight page bulletin (No. 300) on the "Thermobloc" direct fired unit

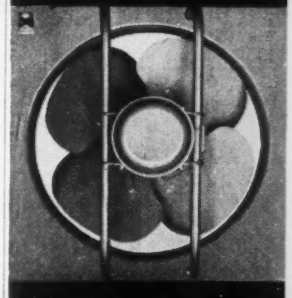
FOR FAST, QUIET AIR MOVEMENT INSTALL

Peerless Electric

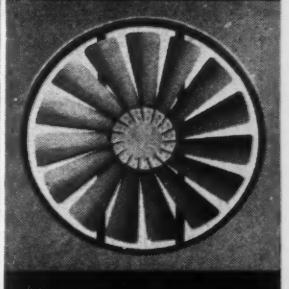
PROPELLER FANS



Type PV Multiblade



Type PVS Deluxe



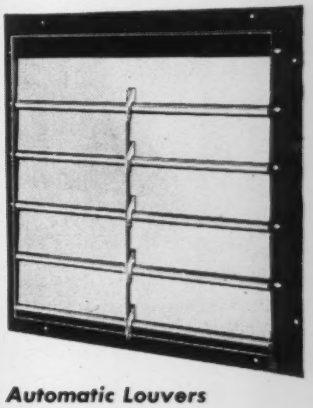
Type PV Multiblade

★

NO matter what your need for quiet, variable speed, attractively designed fans, you'll find the answer in a Peerless Electric design.

A combination of specially engineered capacitor motors and perfectly balanced extra wide blades produces extremely quiet operation. Motors are totally enclosed and permit installation in either a vertical or horizontal position.

These fans are supplied in single-speed, two-speed or three-speed operation and finished in gray. Recommended for stores, restaurants, hotels, offices and similar installations where quietness of operation and attractive appearance are prime requisites. Write for descriptive folders.



Automatic Louvers

Peerless Electric automatic louvers are designed especially for use with propeller fans. When the fan starts, the air stream instantly opens the louvers, which close by gravity when the fan stops. Completely weatherstripped around the inner edge of the frame. Built of high grade aluminum. Sizes from 10 to 48 inches.

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MOTORS • FANS • BLOWERS

heater which has been designed to deliver 550,000 Btu per hr of heated air to the working level at an efficiency of from 82 to 86 percent. Units burn No. 3 oil or lighter, or gas, and occupy a 30 in. diameter floor space. The booklet also describes how a number of units may be used to heat large areas and how they may be used for air circulation in the summer months.

Electric Motors

No. 6928—A 20 page publication, E-M Synchronizer No. 24, contains information on how motors help produce and preserve food, describes coil insulation for large a-c motors, and discusses high inertia loads and the corresponding motor requirements. The booklet is published by Electric Machinery Mfg. Co., Minneapolis 13, Minn.

Electrode Guide

No. 6929—Air Reduction Sales Co., Dept. A19-24P, 60 E. 42nd St., New York 17, N. Y., has published a pocket guide to "Airco" arc welding electrodes. The booklet is said to present all the facts pertaining to the most commonly used company electrodes along with helpful data regarding the factors to be considered when choosing an electrode for a specific job.

Enclosed and Open Blade Type Switches

No. 6930—The line of bakelite enclosed and open blade type switches, offered by Acro Electric Co., 1392 Superior Ave., Cleveland 14, Ohio, is covered in a 24 page illustrated catalog which provides information on a wide variety of shapes, sizes, and operating characteristics.

Finned Heating Tubes

No. 6931—Bulletin No. 471 released by Brown Fintube Co., Elyria, Ohio, describes and illustrates "Convector-tubes". This heat transfer surface consists of either 1¼ in. IPS steel or copper tubes with either steel, copper or aluminum fins. The bulletin describes the "spring-hub" construction, illustrates various applications, and provides data on steam and hot water ratings.

General Purpose A-C Arc Welder

No. 6932—The "Nu-Arc" general purpose welder which does not have any moving parts is described in a catalog sheet published by Electric Arc, Inc., 152-162 Jelliff Ave., Newark 8, N. J. Complete specifications and data on this a-c welder are included.

General Purpose Electric Motors

No. 6933—Information on the general purpose electric motors offered by Allis-Chalmers Mfg. Co., Milwaukee 1, Wis., is contained in booklet 51B6052J. This 12 page bulletin gives detailed specifications on squirrel cage induction motors and application data, range of sizes and speed torque curves on synchronous, wound rotor and d-c motors. It also covers applications and features

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"RADIANT HEATING AND COOLING"

Made up of articles and data on this subject that appeared originally in "Heating, Piping & Air Conditioning," this booklet is the most comprehensive and authoritative collection of information on radiant heating and cooling yet assembled. It tells exactly what radiant heating is, where it can be used, and how to design complete systems. In addition, it contains fully detailed descriptions of numerous panel heating and cooling installations.

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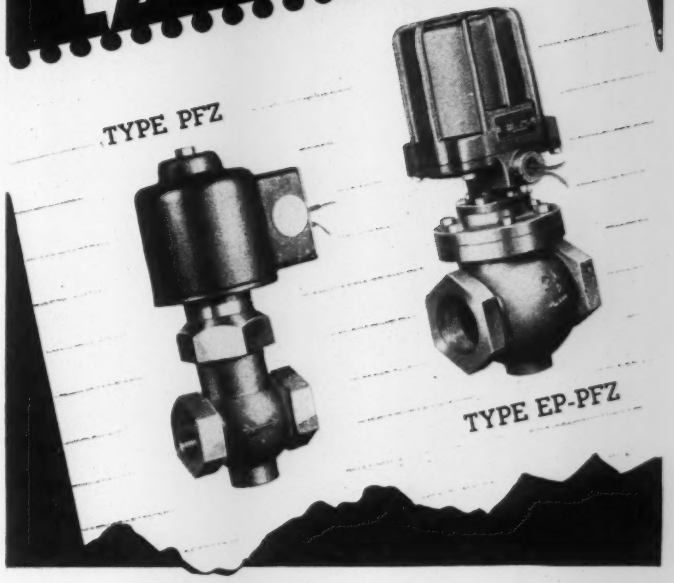
ASCO SOLENOID VALVES of the BULLETIN 8210 CLASS

IDEAL VALVES FOR CONTROLLING REFRIGERANT FLOW

Packless · Straight Through · Full Pipe Area



The Solenoid Valve serves well both as traffic cop and watch dog for refrigerant lines. Its action is sure and automatic when responding to temperature demands, shutting tight and staying tight or opening full as called for by the system.

The ASCO Line of Solenoid Valves for refrigeration systems is quite varied both as to types and sizes. The two illustrated are widely used; being designed for pressures up to 250 psi and temperatures up to 212 F. Standard valves are bronze with screwed connections. Type EP-PFZ valve is the explosion-proof type with valve construction similar to Type PFZ.

Write us about your refrigerant solenoid valve requirements. We are quite certain we have the valves that will fit into your system perfectly.

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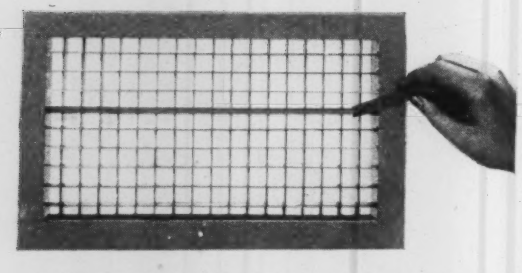
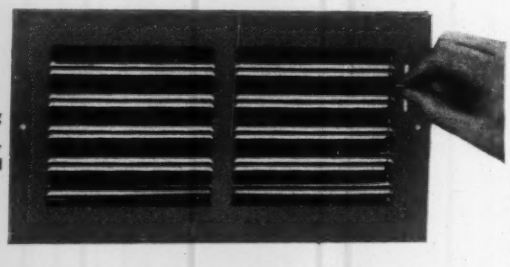


Style DDH Double Directional 2 Banks —adjustable face and rear bars.

Style DDH Stewart high velocity outlet with "All-Way-Selective-Air-Throw" produced by means of a removable key which can adjust any bar at various angles without affecting the setting of any other bar. Horizontal face bars and vertical bars in rear, are both adjustable for any combination of air direction desired.



Style 94 Wall or Ceiling Register Multiple Damper Lever Regulated

Style 94 is designed for wall or ceiling use, with horizontal face bars which are down deflecting. The rear bank of Style 94 Register serves to regulate the air supply and to deflect air into the outlet. Lever operated multivalves control the degree of opening.

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of gearmotors and multi-speed induction motors and carries an induction motor selection chart for units from 1 to 200 hp. Attention is also called to the company's line of motor controls, and charts list the range of each type of control in voltage and horsepower.

Glass Fiber Duct Insulations

No. 6934—"Fiberglas" coated and flexible duct insulation is the subject of an eight page bulletin released by Owens-Corning Fiberglas Corp., 1911 Nicholas Bldg., Toledo 1, Ohio. In addition to describing thermal and other physical properties, the booklet gives information on application methods, finishes, and vapor seals.

Heat Insulating Block

No. 6935—A four page folder describing the properties and advantages of "Kaylo" heat insulating block has been released by American Structural Products Co., Ohio Bldg., Toledo 1, Ohio. Developed at the beginning of the war, the block is said to be a lightweight but strong mineral insulation, capable of withstanding intense heat.

High-Low Signals for Water Level Indication

No. 6936—To extend the use of its remote liquid level indicator, Yarnall-Waring Co., Mermaid Lane, Philadelphia 18, Pa., has developed a new attachment for operation of one or more distantly located electric type (visible or audible) high-low alarm signals and/or controllers for pump motors or other devices. The control unit, described in Bulletin WG-1822, is attached directly to the company's indicator which is operated by the boiler water itself and which registers variations of the level in boilers, feed water heaters, and other storage vessels.

High Temperature Tube Steels

No. 6937—Babcock & Wilcox Tube Co., 85 Liberty St., New York 6, N. Y., has published a new edition of its bulletin on "Croloys" giving technical data on high temperature steels for alloy tubes and pipe. The bulletin offers condensed information in chart form on such factors as creep strength, short tensile strength, oxidation and corrosion resistance, temper embrittlement and minimum physical properties.

Hydraulic Gaskets

No. 6938—A manual on hydraulic "O" rings has been issued by Crane Packing Co., 1800 Cuyler Ave., Chicago 13, Ill. Tabulations of compound specifications, dimensional standards, and data on applications and installations are included.

Industrial Air Conditioning

No. 6939—An article briefly covering some of the factors in industrial air conditioning is featured in the Vol. 4 No. 2 issue of the house organ published by Anemostat Corp. of America, 10 E. 39th St., New York 16, N. Y. Moisture control, control of the rate of chemical and biochemical reactions, the elimination of static

ON CHIMNEYS AND VENT FLUES

Breidert Air-X-Hausters

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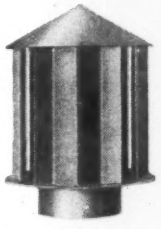
Breidert Air-X-Hauster Chimney Top makes fireplace draw better.

the first scientific improvement in roof ventilators in over 50 years!



Type B Breidert Air-X-Hauster for factories, commercial and residential buildings.

No matter which way the wind blows, no matter how bad the weather—the Breidert *provides positive exhaust.* Designed in accordance with the science of aerodynamics, this revolutionary ventilator utilizes the power of air currents coming from *all angles* to provide safe, positive ventilation without back-draft. Stationary—no moving parts to regulate or get out of order.. no power consumption... compact and pleasing in appearance.

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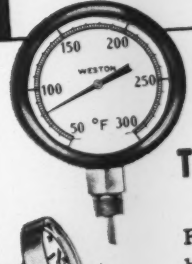

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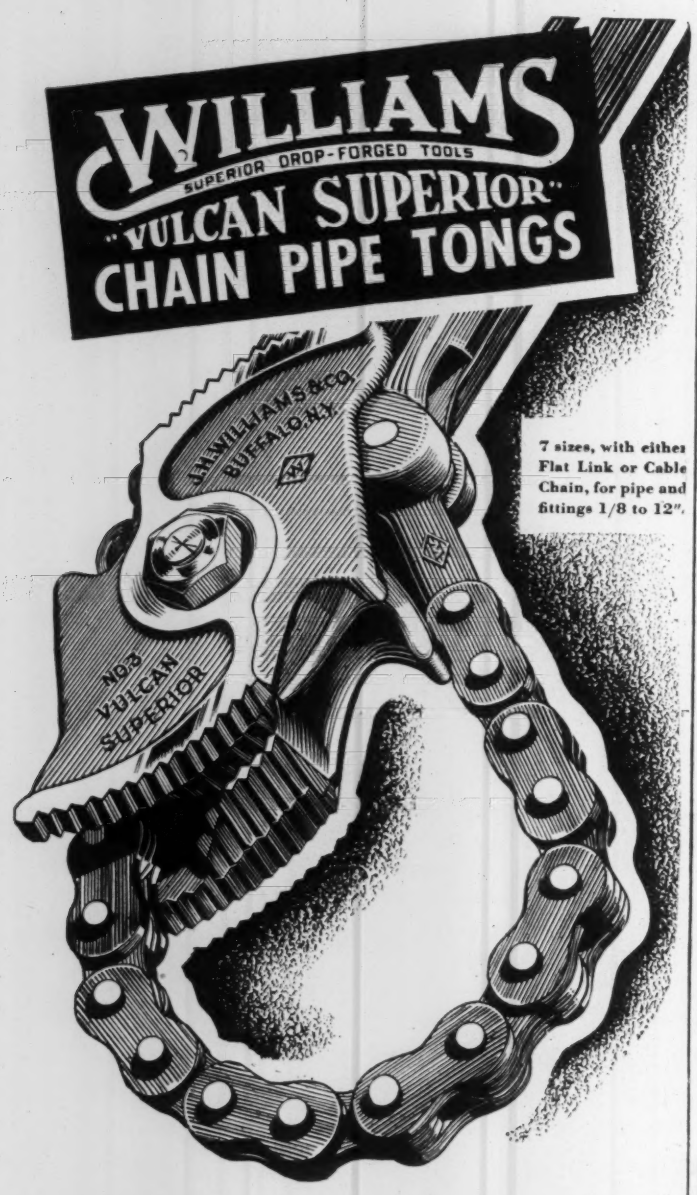

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electricity, temperature, humidity, and air motion are some of the topics discussed. Also included is a brief discussion of air conditioning in candy plants and part two of an article on sound control.

Laboratory Testing

No. 6940—U. S. Testing Co., Inc., 1415 Park Ave., Hoboken, N. J., has published a number of booklets on its testing facilities. Booklets on refrigeration testing and on heating, ventilating and air conditioning tests describe the company's facilities. A testing price list tells of the various tests which can be made by the company. Testing in Modern Industry is the title of a bulletin on the services of the company. Various useful tables of equivalents, conversion factors, and other data pertinent to textile mills are included.

Large Induction Motors

No. 6941—Large induction motors of the squirrel cage, wound rotor bracket bearing and pedestal bearing types are described in a 24 page bulletin (No. 05B6132A) published by Allis-Chalmers Mfg. Co., Milwaukee 1, Wis. The bulletin charts electrical characteristics, representative full load power factors, and the approximate range of starting torques of squirrel cage motors larger than 200 hp.

Large Size Water Strainers

No. 6942—Catalog No. 37 describes the duplex strainers manufactured by R-S Products Corp., Germantown Ave. at Wayne Junction, Philadelphia 44, Pa. They are designed to provide continuous clean water for industrial processing and utility purposes and incorporate two basket strainer units within the main casing, arranged so that either can be cleaned while the other is functioning. Standard strainers range in size from 4 to 24 in. pipe size.

Magnesia Insulation

No. 6943—Control of Engine Room Temperature with Insulation in Diesel-Electric Plants is the title of the leadoff article in the Vol. 2 No. 3 issue of the booklet published by the Magnesia Insulation Manufacturers Association, 1317 F St., N. W., Washington 4, D. C. The author, Edgar J. Kates, consulting engineer, covers the importance of insulation in order to prevent exhaust gases from overheating engine room air and to protect personnel. He also discusses the advantages of using a combination insulation consisting of an inner layer of diatomaceous silica and an outer layer of 85 percent magnesia.

Metal Flexible Tubing

No. 6944—"Titeflex" all-metal flexible tubing is illustrated and described in a 24 page catalog published by Titeflex, Inc., 469 Frelinghuysen Ave., Newark 5, N. J. In addition to brass tubing, the catalog covers the company's bronze tubing for nominal steam pressure applications, together with monel, stainless steel, and inconel tubing. Included are specifications for standard fittings and bendable pipe, high frequency conductors, and vibration eliminators.

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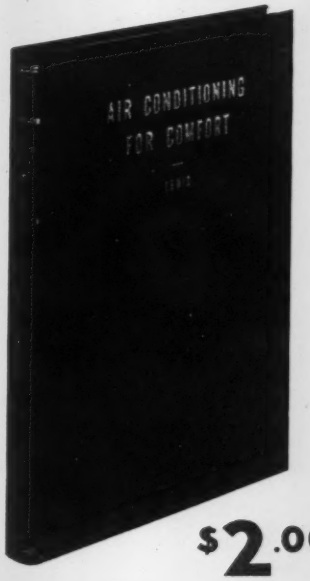

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The chapter devoted to Psychrometry presents nineteen different formulas for psychrometric calculations. In illustrating the correct use of these formulas, Mr. Lewis applies both the psychrometric tables and charts in order to render both devices thoroughly understandable.

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CHAP. 5—The Psychrometric Table and Chart
CHAP. 6—Humidity Controllers and Control
CHAP. 7—Heat Transmission Through Barriers
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CHAP. 9—Heating Systems
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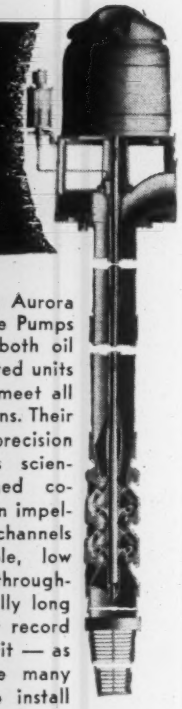

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No. 6946—Motor driven time delay relays (for a-c operation) which consist of a small synchronous motor, a differential gear system, a magnetically operated brake, a trip switch assembly, and an auxiliary relay are described and illustrated in Bulletin 362. The manufacturer is Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.

Multi-Stage Steam Turbines

No. 6947—Worthington Pump & Machinery Corp., Harrison, N. J., has published Bulletin 1961 on multi-stage steam turbines (type S). The units described are for driving boiler feed pumps, process pumps, centrifugal compressors and blowers, fans, generators, etc.

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Paints and Coatings

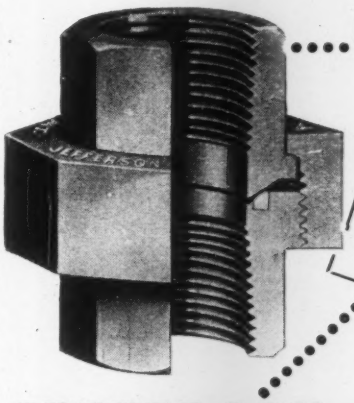
No. 6948—The "Duramite" line of paints and coating materials is said to provide unusually good adhesion and heat resistance and to consist of chemically inert resins. A six page bulletin, issued by Morton Chemical Co., Greensboro, N. C., describes the properties and industrial applications of the line.

Pneumatic Atomizing Nozzles

No. 6949—Pneumatic atomizing nozzles for reducing liquids of all types into atomized sprays are described and illustrated in a simplified catalog (No. 23) published by Spraying Systems Co., 4033 W. Lake St., Chicago 24, Ill. Illustrations and data on a wide range of types are presented, and comprehensive capacity and spray dimension tables are included.

Relative Humidity Indicator

No. 6950—The all-metal relative humidity indicator designed for use in industry and in the laboratory by Weston Electrical Instrument Corp., 619 Frelinghuysen Ave., Newark 5, N. J., is described in a small six page folder. The device is said to provide readings within ± 1 percent and is of the wet bulb type.



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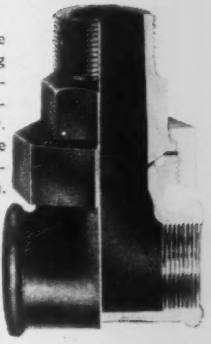

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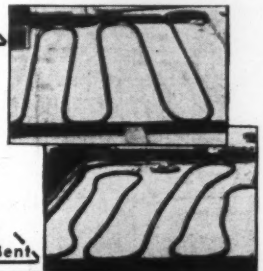

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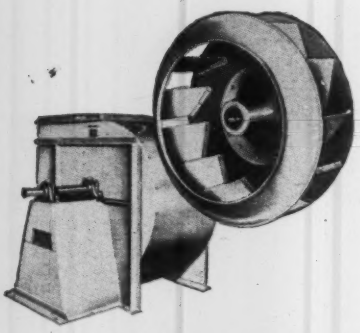

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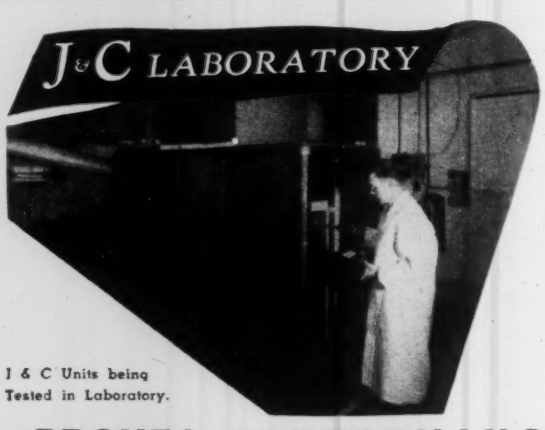

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Replacement Type Air Filters

No. 6951—"Dust Stop" replacement type air filters and their application in commercial and industrial heating, ventilating, and air conditioning systems are covered in an eight page bulletin issued by Owens-Corning Fiberglas Corp., 1911 Nicholas Bldg., Toledo 1, Ohio. Performance data, test methods employed, and typical installation details are included.

Roof Ventilators

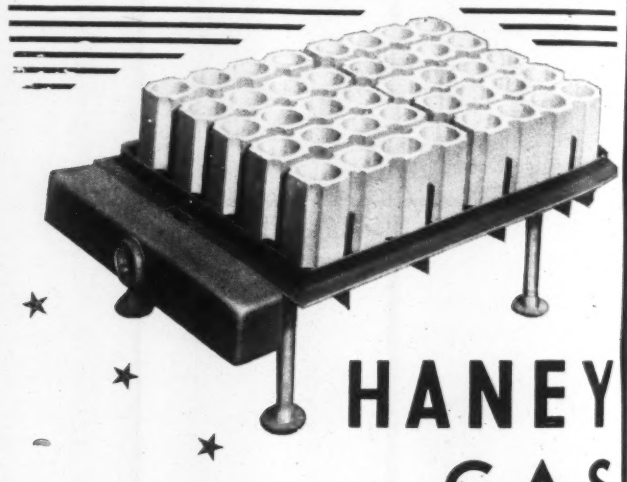
No. 6952—The "Air-X-Hauster" is designed by G C Breidert Co., 3129 San Fernando Rd., Los Angeles 41, Calif., to utilize the power of air currents to remove air from buildings and vessels. It is described in a new bulletin which provides performance data, illustrates the various models available, and shows different types of installations.

Silicone Products

No. 6953—Bulletin No. CDR-57 is a 30 page booklet describing in detail the silicone products available from General Electric Co., Chemical Dept., Pittsfield, Mass. Resins, oils, greases, water repellents, and rubber are described, along with their many industrial uses.

Small Electric Motors

No. 6954—Catalog No. 348 illustrates the entire line of EMC motors and bases and suggests numerous applications. The motors, with ratings up to 1/12 hp, are



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GAS FIRED HEATERS SINCE 1888

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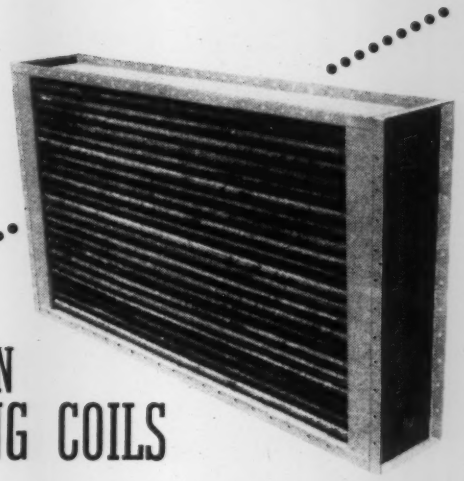

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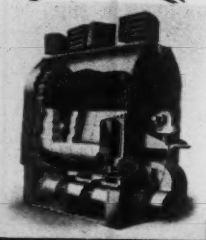

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manufactured in two basic types—brush and sh. dec pole. The catalog also features the gear reducers off red by Electric Motor Corp., Div. of Howard Industries, nc., Racine, Wis.

Speed Control for Boiler Draft Fans

No. 6955—A 20 page booklet on precision speed control for boiler draft fans with the "Regutron" controlled magnetic drive, by G. L. Oscarson, chief application engineer, Electric Machinery Mfg. Co., Minneapolis 13, Minn., discusses principles of operation with graphs, diagrams, and installation pictures. The paper, which was presented to the Pennsylvania Electric Association, is available from the author's company and is identified as 4400-TEC-1078.

Ventilating Fans and Blowers

No. 6956—The line of ventilation equipment offered by Martin Fan & Blower Co., 4632 W. 21st Pl., Chicago 50, Ill., is briefly described in a folder which indicates capacity ranges and applications. Equipment covered includes propeller fans, bucket type exhausters, centrifugal blowers, and various types of duct fans.

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No. 6957—A single page bulletin (L-67) briefly covers the No. 157 water column type pump control, low water cutoff and alarm offered by McDonnell & Miller, Inc.

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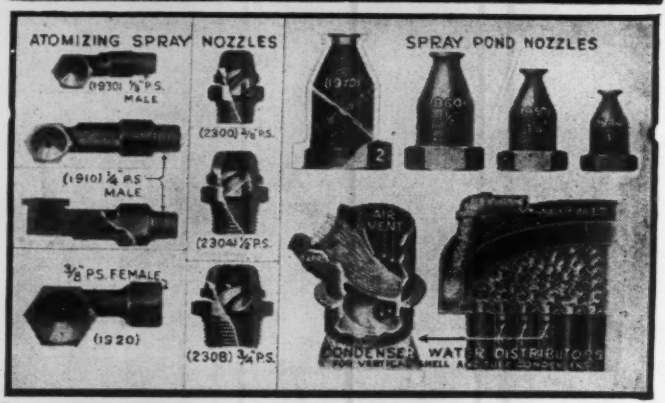

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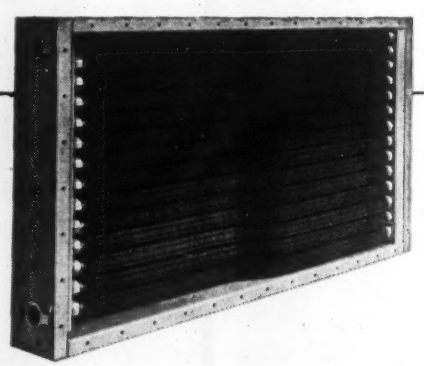

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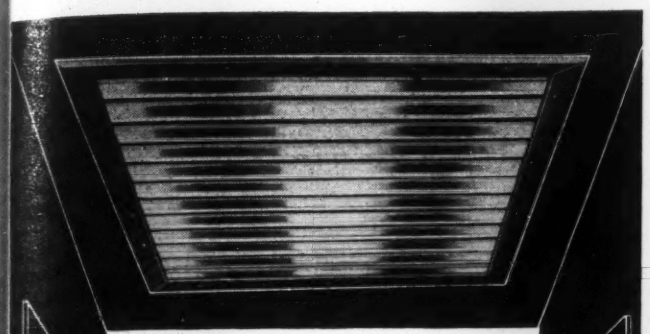

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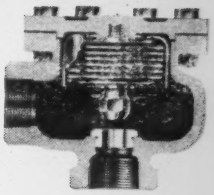

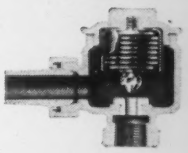

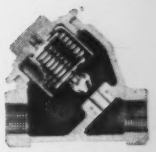

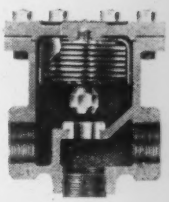

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Bulletin 1047 or see Sweet's

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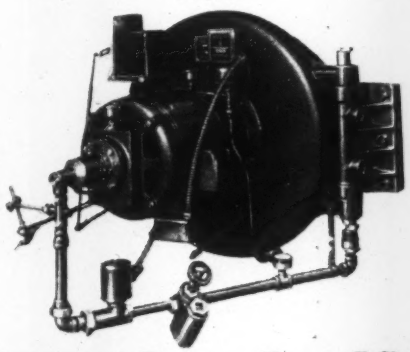

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Semi-automatic control with modulating motor.
Gravity feed with separate pumpset.
Available in twelve siezs, up to 1000 B.H.P.
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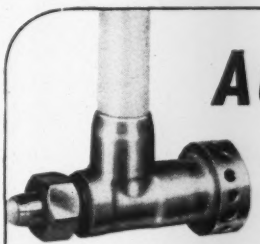

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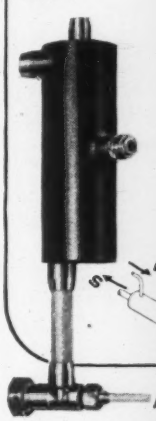
without Moving Parts

Injector with Distributor Head

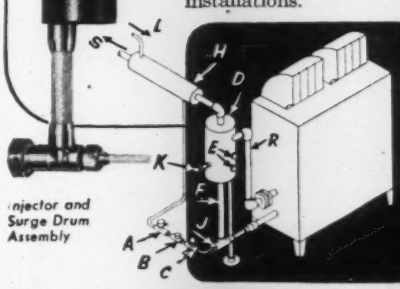


THE PHILLIPS INJECTOR provides completely automatic evaporator feed with *no moving parts*. By supplying recirculated liquid steadily to the evaporator it increases heat transfer and increases the evaporator capacity.

Many existing dry-expansion evaporators can be easily changed to Injector operation, with improved performance assured.

Adaptable to "Freon" applications, from air conditioning and water chilling to cold storage installations with plate coils, fin coils, and unit coolers. Injector capacities from fractional to 200 tons with "Freon". Furnished with either single outlet or distributor head.

Write for sketches showing typical Injector installations.



Injector and Surge Drum Assembly

FLOOR TYPE ROOM COOLER HOOK-UP

A—MAGNETIC SOLENOID
B—BULLS-EYE
C—HAND VALVE
D—SURGE DRUM
E—SIGHT GLASSES
F—LIQUID LEG
H—HEAT EXCHANGER
J—INJECTOR
K—CHARGING CONNECTION
L—LIQUID LINE
R—GAS RETURN
S—SUCTION LINE

H. A. PHILLIPS & CO.

3255 WEST CARROLL AVENUE • CHICAGO 24, ILLINOIS